LIST OF DELIVERABLES

The Baro-Akobo-Sobat Multipurpose Water Resources Development Study Project has generated a set of deliverables which are summarised in the table below. This deliverable is highlighted in grey below.

THE BARO-AKOBO-SOBAT MULTIPURPOSE WATER RESOURCES DEVELOPMENT STUDY PROJECT	
A. The Integrated Water Resources Development and Management Plan	
A.1	Inception report
A.2	Consultation and Communication Plan
A.3	Scoping report
A.4	Baseline, Development Potentials, Key issues and Objectives report
A.5	Strategic Social and Environmental Assessment
A.6	Integrated Water Resources Development and Management Plan
B. Medium and Long Term Projects: Terms of references for feasibility studies	
B.1	**The Integrated BAS Hydropower, Irrigation and Multipurpose Development Programme - Phase 1. Baro-Sobat component**
B.2	The Akobo-Pibor Transboundary Multipurpose Development Project
B.3	Livelihood-based Watershed Management - Taking to Scale for a Basin Wide Impact
C. Short Term Project: Feasibility studies	
C.1	Feasibility Study for the Kinyeti River Multipurpose Development Project
C.2	Feasibility Study for the Majang Multipurpose Project
C.3	Design Details for the Akobo-Gambella floodplains Transboundary Development Programme
D. Project brochure	
D.1	The Baro-Akobo-Sobat Multipurpose Water Resources Development Study Project: General overview
D.2	The Baro-Akobo-Sobat Multipurpose Water Resources Development Study Project: Medium and Long Term Projects

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THE INTEGRATED BAS HYDROPOWER, IRRIGATION AND MULTIPURPOSE DEVELOPMENT PROGRAMME – PHASE 1. BARO/SOBAT COMPONENT

Terms of references

LIST OF TABLES

ACRONYMS AND ABREVIATIONS

BAS	Baro Akobo Sobat
BoQ	Bill Of Quantities
CAMP	Comprehensive Agriculture Master Plan
DBM	Design Basis Memorandum
DO	Dissolved Oxygen
EMP	Environmental Management Plan
ENCOM	Eastern Nile Council Of Ministers
ENSAP	Eastern Nile Subsidiary Action Plan
ENTAC	Eastern Nile Technical Advisory Committee
ENTRO	Eastern Nile Technical Regional Office
ESIA	Environmental and Social Impact Assessment
FIDIC	International Federation of Consulting Engineers
ICOLD	International Committee on Large Dams
IDEN	Integrated Development of Eastern Nile
IWRDMP	Integrated Water Resources Development and Management Plan
IWRM	Integrated Water Resource Management
kV	Kilo Volt
MASL	Meters Above Sea Level
MW	Mega Watt
NBI	Nile Basin Initiative
NBS	Nile Basin System
NCOM	Nile Council Of Ministers
NFE	Non-Farm Enterprises
PHAP	Public Health Action Plan
RDF	Recommended Design Flood
RPSC	Regional Project Steering Committee
SAP	Subsidiary Action Program
SEF	Safety Evaluation Flood
SNNPR	Southern Nations, Nationalities and Peoples' Region
SSEA	Strategic Social and Environmental Assessment
SVP	Shared Vision Programme
TDS	Total Dissolved Solids
ToRs	Terms Of References
TSS	Total Suspended Solids
THMEMS	Transboundary Hydro-Meteorological and Environmental Monitoring System

1. BACKGROUND

1.1 INTRODUCTION

The proposed project is part of implementation of the Baro-Akobo-Sobat Integrated Water Resources Development and Management Plan (BAS-IWRDMPlan). This Plan was completed and accepted by the participating countries (Ethiopia, South Sudan and Sudan) in 2017. The plan includes the identification and detailing of priority projects for rapid implementation.

The "**Integrated BAS hydropower, irrigation and multipurpose development programme – Baro/Sobat Component; Phase 1**" is one of the three "medium/long-term" projects selected by the participating countries. The programme, once fully developed could see the implementation of around **3,400MW of hydropower installed capacity** (all hydropower dams planned on the Baro river and its main tributaries) and **290,000 ha of irrigation** (all the Baro/Sobat "no regret" irrigations projects as defined in the BAS IWRDMPlan). In this first phase, lasting ten years, it is anticipated that 2,070 MW of hydropower would be developed at the Tams (1,700 MW) and Geba (370 MW) hydropower schemes and that resultant flow regulation would support the irrigation of an initial development of around100,000 ha[1] in the Gambella and Sobat floodplains in Ethiopia and South Sudan respectively.

The proposed programme is based on the following:

- **Application of Integrated Water Resources Management (IWRM) principles**. The programme is multipurpose in nature and will include water supply and sanitation, navigation, fisheries, livestock, tourism and watershed management components. Finally, it will also include the development of an electrical interconnection between Ethiopia and South Sudan.

  Great attention must be played to the integration of the multiple sectors from the beginning in the design of the programme in order to ensure that all needs and requirements are taken into account.
- Transboundary planning and benefit sharing between Ethiopia and South Sudan.

1.2 THE BARO-AKOBO-SOBAT SYSTEM

MAIN FEATURES OF THE BAS SUB-BASIN

The Baro-Akobo-Sobat (BAS) River system is a sub-basin of the White Nile and one of its main contributors. The BAS has a catchment area of around 260,000 km² and is shared by Ethiopia, South Sudan and the Sudan. The main rivers of the BAS take their source in the Ethiopian and South Sudan highlands and join the River Sobat in the plains.

The location of the sub-basin within the Nile basin is shown in Annex 1.

BIO-PHYSICAL ENVIRONMENT

Hydrological features

The Baro-Akobo-Sobat sub-basin consists of the Baro River (and its tributaries such as the Birbir), the Akobo river and the Pibor river. After the confluence of the Baro and Akobo, the river is called Sobat in South Sudan. The river makes its way from an altitude of over 3,000 masl in the Ethiopian highlands to

[1] **Based on the assumption that 20,000 ha can be constructed and made operational per year (12,000 ha in Ethiopia and 8,000ha in South Sudan) as from end of Year 5.**

about 400 masl when the Sobat crosses into South Sudan on the way to its junction with the outflow from the Sudd wetlands on the White Nile.

The seasonal rainfall pattern and large flat areas have resulted in the formation of many wetlands. The Machar Marshes are located north of the Baro River upstream of its confluence with the Pibor River. This wetland system in a depression has a hydrology primarily driven by evaporation and local rainfall. Some of the flow that goes from the Baro river system to the wetlands during high flows comes back into the Baro and White Nile rivers downstream (through an extended grassy channel called Khor Adar) although flow estimates vary.

The mean annual outflow of the BAS sub-basin where the Sobat River joins the White Nile is estimated at around 12.6 billion m^3/annum and contributes to half of the White Nile flow at their confluence.

The main features of the hydrographic network are shown in Annex 2.

Bio-physical areas

Four biophysical areas are present in the sub-basin:

i. **Highlands** are mainly situated in the eastern part and to a lesser extent in the southern part of the basin at an elevation varying from around 1,800 masl to 3,000 masl (Mount Kinyeti in the Imatong mountains reaches up to 3,187 masl).

ii. **Escarpments** are generally situated between 1,100 and 1,800 masl. These areas are characterized by very steep slopes (much greater than in the highlands and foothills). Some parts are also flatter like the Boma Plateau, situated between 1,100 and 1,300 masl.

Highlands and escarpments are characterized by very high rainfall (from 2000 to 2500 mm per year) and moderate evapotranspiration compared to floodplains. The rainy season lasts from May to October. Highlands and escarpments are the source areas for significant rivers such as the Baro, Alwero, Gilo, Akobo and Kinyeti and the population density is very high.

iii. **Foothills or Piedmonts** are situated between 700 and 1,100 masl. They form a transition area between escarpments, characterized by very steep slopes and flood plains which are extremely flat. The rainy season lasts from April to September.

iv. The **Floodplains and wetlands** biophysical area covers more than half of the BAS sub-basin. It is situated between 370 and 700 masl. It consists of very flat clay plains that stretch from northwards South Sudan foothills and westwards from Ethiopia foothills to the Sobat river. The rainfall reaches between 600 and 800 mm/year, falling between April and September.

Potential for development

The BAS lowlands host one of the most important mammal migrations of the world (especially in the Boma and Gambella national parks). The main migratory species is the White-eared Kob, estimated to up to 1.2 million. Apart from the White-eared Kob, the migration consists of Tiang, Mongalla gazelle and East African eland all followed by Lion, Jackal and Hyena, Zebra, Bright's Gazelle, Giraffe and Beeisa Oryx, etc.

These natural assets bring a huge potential for ecotourism in the area with wildlife experts considering that the mammal migration of the BAS is equal to that of the Massai Mara – Serengeti, which attracts around 400,000 visitors annually.

There is also a great potential to develop ecotourism in otherparts of the sub-basin, more especially for the following:

- Machar marshes (South Sudan)
- Badingillo natural reserve (South Sudan)
- Kidepo game reserve (South Sudan)
- Mount Kinyeti (South Sudan)

- Kafa biosphere reserve (Ethiopia)
- Sheka biosphere reserve (Ethiopia)
- Yayu biosphere reserve (Ethiopia)
- Etc.

SOCIO-ECONOMIC ENVIRONMENT

Principal livelihood activities in the sub-basin

Rain fed crop cultivation is the principal livelihood activity in most of the basin **where adequate rainfall is available.** The economy, which is largely based on traditional cultivation methods, is subsistence oriented. Production is dominated by cultivating crops such as maize and sorghum for local consumption. The lowland population practise shifting cultivation, mainly for growing sorghum. In South Sudan, more than 95% of households are categorized as subsistence-level rain-fed farmers cultivating small areas using simple manual agriculture implements.

In the semi-arid to arid areas of the sub-basin pastoral livestock becomes predominant. Livestock as a source of livelihood is more important for the South Sudan side of the basin where there is a high concentration of cattle, sheep, and goats.

Farm employment (combining crop and livestock production) constitutes the primary form of employment for the population. The communities in the sub-basin basin (both in Ethiopia and Sudan) appear to have very limited experience in accessing cash income due to the remoteness and inaccessibility of the region from regional market centres

Fishing is also an important component of the livelihood strategies of communities that live along the rivers and wetlands in the sub-basin. The Baro-Akobo-Sobat sub-basin has a high potential for flood plain aquaculture, but lacks efficient aquaculture technologies.

Potential for development

The high rainfall, fertile lands, and rivers of the basin offer significant potential for agricultural growth. Furthermore, the potential for large-scale hydropower development has already been identified in the highland areas.

KEY ISSUES AND CHALLENGES

The general key issues and challenges encountered in the sub-basin are summarised in the table below.

Table 1-1: Key issues and challenges encountered in the sub-basin

Bio-physical environment: key issues identified	Socio-economic environment: key issues identified
• Stress on Wetlands • Loss of biodiversity • Unsustainable hunting of wildlife • Loss of natural forest • Soil erosion • Scattered settlements • Poor agriculture extension and poor credit facilities • Flood and drought • Lack of peace and security • Poor physical and social infrastructure	• Poverty and Food Insecurity • Low level of well-being • Lack of peace and security • Low level of provision of social services • Vulnerable groups • Gender inequality • Scattered settlements • Poor agriculture extension and poor credit facilities • Recurrence of various forms, intensity, duration and impacts of conflicts

• Climate change • Lack of knowledge	• Potential for influx of people • Flood and drought • Land security/land tenure issues • Basin population dynamics place heavy pressure on natural resources • Climate change

1.3 ETHIOPIA COUNTRY BACKGROUND

DEMOGRAPHIC FEATURES

The Ethiopian part of Baro-Akobo-Sobat sub-basin includes Gambella Regional State and parts of Oromia, SNNPR and Benishangul-Gumuz regions. The combined current population of the these parts of Ethiopia in the BAS sub-basin is estimated at 3.04 million. The majority (i.e. 88.4%) of the people live in rural areas and the rest 11.6% are urban residents.

The highlands of the BAS sub-basin in Ethiopia (in Oromia and SNNPR) are relatively densely populated with average crude density varying from 43-70 people per km², whereas areas the Gambella and Benishangul-Gumuz regions are less populated, with the average crude density varying from 10-16 people per km².

SOURCES OF INCOME

The main occupation of rural households in Ethiopia are farming and livestock rearing. Some households are also engaged in non-agricultural enterprises. Main sources of income are crop and livestock sales. A rural socio-economic survey indicated that at national level, 79% of households cultivate land, 76% rear livestock, 72% are engaged in both livestock and farming.

Non-farm enterprises (NFE) are important in the lives of households and their number is increasing. Nationally, about 28% of households have one or more NFE. About 60% of households in small towns and 34% of households in large towns reported having one or more NFE, compared with 26% among rural households (ERSS, 2015). The three most important NFE activities are non-agricultural businesses or services from home including shops (about 8% of households), selling processed agricultural products including food and local beverages (6% of households), and businesses such as selling goods on a street or in a market (about 5% of households).

ACCESS TO ELECTRICITY

Ethiopia has a considerable renewable energy endowment, with an abundant hydropower potential, solar and geothermal, as well fossil fuels. Hydropower constitutes almost 92.5% of the total energy mix and thermal energy comprise of 7%. Currently, Ethiopia has around 2,000 MW of installed power generating capacity, out of which 1,980 MW (99%) is generated from hydropower plants. The remaining 12 MW (0.6%) and 8 MW (0.4%) comes from thermal and geothermal sources respectively. In the coming five years the electricity generating capacity is expected to reach 10,000 MW from the current level of 2,000 MW thereby, the electricity coverage of the country will be 75%.

OTHER ENERGY SOURCES

In rural Ethiopia, 85% of the population uses biomass energy sources. The biomass sources comprise firewood (90.7%), animal dung crop residues and others (8.1%) and charcoal (0.2%). All these energy sources are used for cooking, baking, heating, lightening etc. The main sources of energy in the Ethiopian part of the BAS Sub-basin are firewood (56%), animal dung (16%), charcoal (8%). While 6% of the households use kerosene, less than 1% of households use electricity and gas.

1.4 SOUTH SUDAN COUNTRY BACKGROUND

DEMOGRAPHIC FEATURES

The South Sudan part of Baro-Akobo-Sobat sub-basin includes Jonglei, Upper Nile and Eastern Equatoria states. The estimated current population of the these parts is 2.7 million. (Central Bureau of Statistics, 2012). The population is also overwhelmingly rural, with between 85 and 90% of the population living in rural areas. (NBS, 2010). The highest densities of population are found along rivers, in particular the area along the Sobat River.

SOURCES OF INCOME

Crop production (agriculture) is one of the natural resources practices, as means of earning cash and foodstuff for sustaining livelihoods. Rainfed agriculture is the most common farming system. Mixed cropping, poultry and livestock production are other common practices, along with shifting cultivation. In both highland and lowland areas, the use of agricultural inputs such as fertilizers, agro-chemicals, improved seeds, tractors and other machinery is still minimal. Fishery is another important source of income, especially in the lowlands.

A significant proportion of the population is extremely vulnerable to food insecurity due to direct and indirect impact of conflicts, disruption of livelihoods, high dependence on markets and exposure to food price volatility. According to the Comprehensive Agriculture Master Plan (CAMP), over 95% of the total area of South Sudan is considered suitable for agriculture, 50% of which is prime agricultural land where soil and climatic conditions allow for production of a wide range of agricultural products, including annual crops such as grains, vegetables, tree crops such as coffee, tea, and fruits, livestock, fishery and various forest products. Despite of this potential, only 4% of the total land is under cultivation most of which are rain fed while the largest part of the country is still under trees and shrubs (62.6%).

ACCESS TO ELECTRICITY

Only about 1% of the population of the country has access to grid electricity. Most of these consumers are in Juba, with the remaining in Wau and Malakal. Installed capacity for the country is about 30 MW, of which about 22 MW is currently operational.

OTHER ENERGY SOURCES

Current energy needs in South Sudan are predominantly met by biomass, consisting of the burning of charcoal, wood, grass, cow dung and agricultural residues. According to the National Baseline Household Survey in 2012, over 96% of the population use firewood or charcoal as the primary fuel for cooking (which typically constitutes 90% of the energy used in a rural household).

1.5 THE BAS IWRDMPLAN

ORIGIN OF THE BAS MULTIPURPOSE DEVELOPMENT STUDY PROJECT

The Nile Basin Initiative (NBI) is a partnership for regional cooperation initiated and led by the riparian states of the Nile River through the Council of Ministers of Water Affairs of the Nile Basin states/countries (Nile Council of Ministers, or NCOM). The NBI started with a consultative and participatory process of dialogue among the riparian countries that resulted in their adoption of a "Shared Vision" - to "achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources" through sustainable and equitable development; efficient water management and optimal use of resources; cooperation and joint action

between the riparian countries, seeking win-win gains; and targeting poverty eradication, and promoting economic integration.

The NBI has developed two sets of complementary and mutually reinforcing programs to translate the Vision into concrete actions that benefit all peoples in the basin. One program is the basin-wide **Shared Vision Programme (SVP)** aimed at creating and sustaining the enabling environment for cooperative management and development of water resources; the other is the **Subsidiary Action Programmes (SAPs)** aimed at identifying and cooperatively developing projects to realize physical investments that yield win-win gains to all riparian states. For operational purposes the SAP is divided into two sub-basin programmes, one covering the Eastern Nile sub-basin, consisting of states Egypt, Ethiopia, South Sudan and Sudan (see location map – Annex 1); and the other is the Nile Equatorial Lakes sub-basin covering Burundi, Democratic Republic of the Congo (DRC), Kenya, Rwanda, Tanzania and Uganda.

The Eastern Nile Technical Regional Office (ENTRO), established by the **Eastern Nile Council of Ministers (ENCOM)** of water affairs in the Eastern Nile countries, is responsible for managing the **Eastern Nile Subsidiary Action Program (ENSAP)**, whose overall objective is the cooperative development of the water resources of the Eastern Nile Basin, which include the Baro-Akobo-Sobat River Basin, in a sustainable and equitable manner to ensure prosperity, security, and peace for all its peoples. In pursuit of this objective, ENTRO has formulated the **Integrated Development of the Eastern Nile (IDEN)** as a suite of integrated development projects including hydropower, irrigation and drainage, flood control, watershed management, and water resources management. Because of its regional water and land resources potentials and the role it can play in regional peace, stability and security, the Baro-Akobo-Sobat Multipurpose Water Resources Development Study Project became one of the seven (7) projects identified in the IDEN.

THE BAS IWRDMPLAN AND THE DEFINITION OF THE PROPOSED PROGRAMME

The IWRDMPlan is the key deliverable of the study; its main objectives are to:

- Establish a shared vision of the future development of the sub-basin as well as the strategic objectives required to reach this vision;
- Identify principles of water resource management as well as water-linked ecosystem management and,
- Review, evaluate and recommend the institutional framework required for the implementation of the plan (roadmap).

As part of the plan, nine potential priority medium/long term projects were defined. Out of these nine projects, three projects were selected by the countries. They are the following:

i. The Integrated BAS hydropower, irrigation and multipurpose development programme – phase 1. Baro/Sobat Component

ii. The Akobo/Pibor transboundary multipurpose development project

iii. The livelihood-based Watershed Management – Taking to Scale for a Basin wide Impact

For these projects, a more detailed analysis of the key features of the projects has been carried out to compile terms of references for their implementation.

The current terms of references relate to the first priority medium term project: i. The Integrated BAS hydropower, irrigation and multipurpose development programme – phase 1. Baro/Sobat Component.

1.6 THE INTEGRATED BAS HYDROPOWER, IRRIGATION AND MULTIPURPOSE DEVELOPMENT PROGRAMME; BARO/SOBAT COMPONENT; PHASE 1

The proposed programme aims to implement major water resources infrastructure on the Baro and Sobat rivers and to maximise the multipurpose opportunities associated with them. At the heart of the proposed development will be the construction of hydropower schemes and their associated reservoir storage on the Baro River and its tributaries in the Ethiopian highlands. In total,7 hydropower schemes (installed capacity 3,400 MW) have been identified in the Ethiopian highlands. Two schemes, the TAMS scheme (1,700 MW) and the Geba 1 and 2 (372 MW) have been prioritised for implementation over the next ten years and are included in Phase 1. Feasibility studies for both the TAMS and Geba schemes are currently being carried out by the Government of Ethiopia and are near completion. However, these studies are focussed on the generation of hydropower and do not fully take into account multipurpose opportunities at the local or basin wide level. Under the proposed programme it is envisaged that reservoir storage for hydropower generation will be included as part of the proposed integrated development programme with an important role to play in the regulation of flows in support of downstream irrigation development and other important multipurpose development opportunities including navigation and trade, fisheries and aquaculture, livestock production, tourism, water supply and sanitation, and the support of the ecoservices on which a large part of the riparian population relies on. While Phase 1 includes only the TAMS and Geba schemes it is important to note that the TAMS Dam/reservoir is downstream-most development and is the largest of all the proposed reservoirs. It's proposed storage capacity is approximately equivalent to the mean annual runoff of the Baro River at that point.

1.7 LOCATION OF STUDY AREA

The primary study area comprises the Baro and Sobat Rivers and in particular the sites related to the identified project components. However the Baro and Sobat rivers are part of the BAS sub-basin and the potential impacts, positive and negative basinwide should be taken into account where relevant.

2. OBJECTIVES AND OVERVIEW OF THE ASSIGNMENT

2.1 GENERAL OBJECTIVES

The objective of the overall project or programme is to develop *Phase 1 of the Baro-Sobat Component of the Integrated BAS Hydropower, Irrigation and Multipurpose programme*.

The objective of this study is to make ready for implementation the *Integrated BAS hydropower, irrigation and multipurpose development programme – phase 1.* The first step in conducting the assignment shall be to carry out the overall feasibility study (or "the feasibility study at both the programme level and the individual component level") and thereafter prepare detailed designs and tender documents (once the projects are confirmed as feasible). The final output will include feasibility study reports, detailed (final) designs and tender documentation which will form the basis for investment finance mobilization and downstream project implementation. The objective of the study covered by this terms of reference is to complete the feasibility study and associated environmental impact assessments.

2.2 SPECIFIC OBJECTIVES

The work to be carried out is divided into 5 components, with Component 1 being the preparation of the overall integrated programme and effectively encompassing the other 4 components. Component 1

includes all the cross-cutting and enabling aspects and actions and runs throughout the length of the assignment, from the Inception Phase onwards. The Inception Phase has been included under Component 1 because, as the overarching component it includes the preparatory work for all of the components and their mutual coordination. It is important to note that the components are not carried out in sequence. The water resource modelling for example, requires information on reservoirs characteristics and details on irrigation requirements, which will become increasing detailed as the work on components 2 to 5 proceeds. The work carried out under Component 1, will perhaps be iterative in nature with the necessary accuracy and detail being improved through the process.

Table 2-1shows the roadmap for implementation of the programme. It also shows how the various components of the overall programme could fit together and it gives an indication of the possible timing of feasibility studies, design, construction and implementation of the various components. The scheduling should be considered as speculative although in same cases based on the latest information related to national plans.

2.2.1 Component 1: Overall multipurpose Water Resources Development Programme

Component 1 includes the overall preparation of the programme for implementation of the different components included in this programme. It comprises the feasibility studies, management and operation systems, institutional framework and monitoring and evaluation system.

2.2.2 Component 2: Core infrastructure components

COMPONENT 2A: TAMS HYDROPOWER

The schedule shows that construction of TAMS dam could start as early as Year 2 (2018/19), well ahead of other components of the programme. In view of the fact that the regulation of flows is required for irrigation development in the Gambella flood plains and from the Sobat River, the advanced development of the TAMS project has advantages but it is important that some aspects of the design, together with proposed operation and management rules for hydropower and regulation take into account the findings of the overall feasibility.

COMPONENT 2B: GEBA HYDROPOWER

The schedule shows that the construction of Geba dam could start in parallel to the construction of TAMS dam. It is thus important that the design, operation and management rules take into account the findings of the overall feasibility.

COMPONENTS 2C AND 2D: BARO AND SOBAT IRRIGATION

Irrigation schemes have been studied in both the Gambella (Baro) and the Sobat plains.

In Gambella, the main studies on irrigation are the following:

- Baro-Akobo basin master plan –Study of water and land resources of the Gambella plains, EVDSA, 1990
- Baro-Akobo integrated development master plan study, MoWR, 1997

Irrigation in the Gambella plain is planned in the GTP-II (Growth and Transformation Plan II). The plan is based on the above studies and 250,000 ha of large scale irrigation are planned on the Baro river.

For the Sobat floodplains, the main study on irrigation is the Irrigation Development Master Plan (MEDIWR, 2015) in which 72,000 ha are proposed for irrigation on the Sobat.

It is assumed that (as part of the proposed programmes), these irrigation schemes will be developed and made operational at the following rate (starting from around Year 5 of the programme):

- 12,000 ha per year for the Gambella flood plains and
- 8,000 ha per year for the Sobat flood plains.

The current status of the basins water resources environment, including floodplains and associated wetlands, will change. This change will be both in steps and gradual as hydropower projects such as TAMS come on line and as irrigation projects are incrementally developed.

2.2.3 Component 3: Other infrastructure components

Component 3 includes the other infrastructure sectors which should be studied as part of the overall programme. These sectors that can beneficiate form the main infrastructure are the following:

- Component 3A: Navigation
- Component 3B: Hydropower interconnection
- Component 3C Fisheries and aquaculture
- Component 3D: Livestock production
- Component 3E: Tourism and other development sectors
- Component 3F: Water supply and sanitation

2.2.4 Component 4: Cross cutting and enabling components

One important result of the proposed development will be a gradual increase in the level of urbanisation in the sub-basin with the growth of several urban poles. A major driver of these poles is seen as the proposed irrigation development which should generate a range of downstream opportunities including agro-processing and the development of a wide range of service industries associated with urban growth. The presence of a growing urban population will also catalyse the development of both fisheries and livestock production including dairy.

The overall feasibility study, which is at the centre of this terms of reference will take into account the full range of potential benefits and impacts that should result from the proposed water resources development programme.

Table 2-1: Roadmap for Implementation of the Project

Components	Year 0				Years									
	Q1	Q2	Q3	Q4	1	2	3	4	5	6	7	8	9	10
0. Project Preparation and Procurement														
0A: Finalisation or ToR, approvals at national and regional levels														
Updated draft by ENTRO														
Approval by countries and ENTAC														
0B: Procurement														
Procurement/Appointment of ENTRO Project Coordinator														
Finalise and publish RFP														
Negotiations and Appointment of Consultant Team														
Project Kickoff														
1. Overall Multipurpose WRDevelopment Programme														
1A: Programme preparation; stakeholder consultation														
Inception - scoping														
Baseline														
Feasibility (incl ESIA)														
Programme Implementation														
1B: Management and operation systems														
Feasibility														
Design														
Implementation														
1C: Institutional framework														
Design														
Implementation														
1D: Monitoring and Evaluation System														
Design														
Implementation														
2. Core Infrastructure Components														
2A: TAMS Hydropower														
Feasibility and ESIA review and completion														
Design (incl ESIA)														
Construction														
Implementation														
2B: Geba Hydropower														
Feasibility and ESIA review and completion														
Design														
Construction														
Implementation														
2C: Baro Irrigation														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
2D: Sobat Irrigation														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														

	Fully covered by ToR
	Only partly covered by ToR
	Not covered by ToR

Components	Year 0				Years									
	Q1	Q2	Q3	Q4	1	2	3	4	5	6	7	8	9	10
3. Other Infrastructure Components														
3A: Navigation														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
3B: HP Interconnection														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
3C: Fisheries and aquaculture														
Feasibility (incl ESIA)														
Design														
Implementation														
3D: Livestock production														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
3E: Tourism and other development sectors														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
3F: Water supply and sanitation														
Feasibility (incl ESIA)														
Design														
Construction														
Implementation														
4. Cross-cutting and enabling components														
4A: Watershed management														
Feasibility														
Design														
Implementation														
4B: Transport and communications														
Feasibility														
Design														
Construction and Implementation														
4C: Other service sectors (health, education etc)														
Feasibility														
Design														
Construction and Implementation														

Fully covered by ToR
Only partly covered by ToR
Not covered by ToR

3. GENERAL SCOPE AND METHODOLOGY OF THE STUDY

3.1 COMPONENT 1: OVERALL MULTIPURPOSE WATER RESOURCES DEVELOPMENT PROGRAMME

3.1.1 Component 1A: Programme preparation; stakeholder consultation

PHASE 1: INCEPTION AND SCOPING

Task 1: Inception

During this phase, the consultant is expected to revise and refine the proposed methodology, incorporating wherever relevant, new information and/or comments. In addition, a clear schedule of activities, responsibilities and work plan should be proposed for validation by the Client during the inception workshop. **The Project Inception Phase is to cover all components (1 to 4) of the project**. One of the aims is to have a clear understanding of the status of all components and how they fit together in terms of logic and scheduling.

The project Inception Phase will start with a kick-off meeting during which the planning of Inception activities will be presented and discussed with the Client. It will also be an opportunity to meet some key stakeholders and to initiate the data collection and review process.

Task 2: Scoping

The main purpose of the scoping exercise is to identify the existing data and information, assess the gaps and propose actions to fill in the gaps. The Scoping and Inception exercises should be perform in parallel as the methodology may be modified in response to the data gap analysis.

Due to the relative data paucity within the area, the consultant is expected to concentrate efforts on conducting a thorough review of information available for the area; the consultant shall critically assess the validity and source of all data. Information collected should include, but is not limited to:

- Climate and water resources: temperature, rainfall/runoff data, water quality indicators (e.g. dissolved oxygen, pH, nutrients, etc.), climate change projections, etc.
- Catchment characteristics: topography, geology, land cover and land use
- Socio economic characteristics: information on livelihoods (especially agriculture, livestock rearing and fisheries), potential conflicts, institutions
- Water resource use for consuming and non-consuming uses such as agriculture, water supply, agriculture, fisheries, sanitation, navigation, etc.
- Biodiversity and related ecosystems: species diversity, population trends, threats, etc.

Key documents to be reviewed include the documents delivered during the Integrated Water Resource Development and Management study project (ENTRO, 2017), in particular the following deliverables:

- The Strategic Social and Environmental Assessment (SSEA)
- The Integrated Water Resources Development and Management Plan (IWRDMPlan)

From the review, the consultant should identify main data deficiencies, and incorporate within the work plan and activities a detailed strategy and schedule for an on-field data collection programme.

Field visits to the critical and representative parts of the sub-basin should be allowed for as part of the scoping work. A proposed field visit programme should be presented at the Kick-off meeting for discussion

The objectives of the Inception/Scoping are thus twofold, i) to do the usual preparatory work to allow the work of all the components to proceed in a coherent manner and ii) to plan for rapid implementation of a monitoring system that can run for a number of years under this project, aimed at collecting the key information required.

Deliverable: Inception and scoping report (3.0 months)

Workshop 1: Inception workshop (4 months)

PHASE 2. BASELINE STUDY OF THE HYDRO-ENVIRONMENTAL CHARACTERISTICS OF THE BARO AND SOBAT

The deliverable of Phase 2 will be the **Overall Development Programme Baseline Report**. A first draft is to be delivered for presentation at the end of month 16. It will make use of data collected during the first year of the project following project Inception. The baseline report will include a comprehensive database and related maps, developed in such a way that the details of the draft baseline report can be updated as further improved data become available during the course of the project.

Task 1. Hydro-environmental data and information collection

Sub-Task 1.1 Data and Information collection for the system

The work carried out under the BAS IWRDMPlan has shown that the available data are inadequate. The consultant is expected to use the data that is made available by the planned Transboundary Hydro-Meteorological and Environmental Monitoring System (THMEMS) to be implemented across the basin as part of implementation of the IWRDMPlan. However, in the event that the first series of data is not yet available, the Consultant must plan and ²&make provision for the collection of their own data collection programme covering at least one full year. Elements of the data collection programme should continue indefinitely and be integrated into the THMEMS. These data should include, but not be limited to:

- River level and discharge including flood plain inundation
- Water quality (e.g. nutrients, temperature, DO, pH)
- Sediment load monitoring (e.g. TDS, TSS)
- Meteorological information (e.g. temperature, rainfall)
- Erosion monitoring
- Land use/land cover monitoring
- Aquatic biodiversity (incl. macrophytes and fish)

The cost of setting up and operating (for one year) this data collection programme is to be quoted as a provisional sum.

In addition, the consultant will have to coordinate with ENTRO in order to ensure that the stations established are in concordance with any stations already in use or planned by the THMEMS, matches the quality and quantity of the data collected by any stations already in use by the THMEMS and can be fully integrated into the THMEMS once the project is finished.

The consultant shall ensure that it has all the relevant information that is needed for any models that will be created in order to complete subsequent tasks.

Sub-Task 1.2 Data and information collection on consumptive use

The Consultant should collect all relevant studies, data and information relatedto the consumptive use of water in the region. Such uses should include but are not limited to:

- Food production
- Agricultural use – points of abstraction, irrigation schemes, crop requirements, return flows
- Potable water use
- Livestock use
- Industry/manufacturing

Where data or information is lacking or out of date, the consultant is expected to conduct field surveys in order to ensure the relevance and temporal accuracy of these consumptive uses. The Consultant must gather information for the entirety of the study area defined, with a particular emphasis on important urban areas, irrigation schemes.

Sub-Task 1.3 Data and information collection for non-consumptive use

The Consultant should collect all relevant studies, data and information related to the non-consumptive use of water in the region. Such uses should include but are not limited to:

- Navigation
- Hydropower production
- Fisheries
- Sanitation
- Ecosystem services

Where data or information is lacking or out of date, the consultant is expected to conduct field surveys in order to ensure the relevance and temporal accuracy of these uses.

Task 2:Socio-economic data and information collection

A full socio-economic profile of the project area is to be developed. This should focus on the immediate projects areas and also on areas of potential project impact by making careful consideration of the types and geographical distribution of impacts (positive and negative)

The profile should rely on available data where up-to-date and supplement this with field surveys.

Task 3: Development of modelsand calibration of baseline conditions

A range of models will have to be set up and calibrated under baseline (current status of development) conditions. These same models will be used to investigate the programme conditions in a later phase. Their topology and design should make allowance for all possible combinations of multipurpose development in the future.

Sub-task 3.1 Hydrological and Hydrodynamic Modelling

It is anticipated that the Consultant will have to make use of a range of water resources models including the following:

- Rainfall-runoff models
- Water balance / water allocation models
- Hydrodynamic models

Using the data collected, the Consultant is expected to build a system of models which can be utilised to assess various operating principles and management (in particular of upstream reservoirs, but also of the proposed irrigation schemes). These models will be required to provide the necessary information for all key locations and/or river reaches. These will be defined and agreed in close consultation with the Client and stakeholders.

Sub-task 3.2. Building of the economic impacts model

In order to facilitate the comparison of the various management and operations scenarios, the consultant is expected to create an economic model which will value the changes of consumptive and non-consumptive uses of water. The consultant is expected to use the information collected during the baseline. The model should be as "complete" as possible, taking into account the wide range of potential externalities.

Task 4: Stakeholder Consultation plan

As part of the baseline study, the Consultant should draw a consultation plan for the subsequent phases of the study. This plan should include the following:

- Report on the Rapid stakeholder analysis
- Plan for stakeholder consultation
  - Objectives of consultation
  - Elaboration of the consultation plan

The stakeholders' consultation plan will be included as an annex to the baseline report.

Deliverable: Overall development programme baseline report (16 months)

Workshop 2: Baseline workshop (16.5 months)

PHASE 3:OVERALL PROGRAMME FEASIBILITY AND ESIA

Phase 3 will include the following tasks:

Task 1: Analysis of Options

This will integrate all the work on operation and management rules aimed at seeing how best to operate and manage the system. The analysis will include a cost-benefit analysis which should take into account all the details developed at the levels of Components 2 – 4:

- Feasibility studies of "core infrastructure components"
- Feasibility studies of "other infrastructure components"
- Feasibility studies of "cross-cutting and enabling components"

It will also take into account the costs and benefits associated with cross-cutting opportunities and impacts (navigation, interconnection, impact on eco-services, trade, etc.)studied as part of the baseline study (Component 1A – Phase 2).

Task 2: Detailing of the chosen development option

Once the preferred development option for the overall programme (including the detail of all components) has been chosen, the details of each sub-component will be fully detailed and the preliminary design carried out both for the overall programme and each of the components and sub-components (see also terms of reference for the Components set out in the following paragraphs).

A key part of the overall design will be the design of the basinwide operation and management system, especially relating to the operation of dams/reservoirs and irrigation schemes. This design will be built on the modelling carried out earlier and assuming the preferred option.

Task 3: Economic and financial analysis of the overall programme

Using costings based on the preliminary design work, a detailed and refined economic and financial analysis will be carried out in order to present in the most complete manner, the feasibility of the overall programme. Costs and benefits should be provided at the overall project/programme level and broken down by country.

Task 4: Institutional Framework

The institutional framework for implementation of the overall programme and its individual components is to be detailed. Special focus should be on transboundary aspects and the institutional implications of implementing an integrated transboundary multipurpose project

Deliverable: Overall programme feasibility report including ESIAs (60 months)

The overall programme feasibility report should also include the main results from Components 1B, 1C and 1D. As this phase is very long, the Consultant will be expected to provide progress reports on a regular basis. **The Consultant shall propose workshops corresponding to significant milestones in his proposal.**

PHASE 4: PROGRAMME IMPLEMENTATION

Only part of the programme will be implemented under these ToRs. The Programme feasibility (Component 1A) and more importantly the chosen development option will be used as part of the Management and Operation system (Component 1B). Based on the results of Component 1A, the Management and Operation System aims at providing real-time or quasi real-time operational rules to be used as soon as the first major infrastructure elements are implemented.

3.1.2 Component 1B: Management and Operations systems

PHASE 1: FEASIBILITY STUDIES

This will overlap with work under 1A, but the focus should be on the demonstration of the feasibility of implementing a quasi-real-time system. Clearly such a system has significant associated “construction” costs and operational costs (capacity/institutional aspects as well) but it is important to demonstrate the potential savings when infrastructure is designed, implemented and operating based on an improved level of understanding.

PHASE 2: DESIGN

It is important to realise that the design of the system is based on a statistical (historical) analysis. Operation in a real-time environment is different. Operational decisions are based on the current situation at a given time taking into account the likelihood of what may happen over the next days/months. Since the operation and management system has to operate in a real-time or quasi real-time environment, it is necessary to have real-time data available to support decision-making according to agreed rules. The tasks can be summarised as follows:

Task 1: Development of real time monitoring needs

The consultant is to design a real-time management system and associated components which will take into consideration the following information:

- Meteorological data – the system should provide for analysis of both local (i.e. use of THMEMS) and larger scale (i.e. satellite imagery) data to inform on short and longer term weather patterns. Rainfall is included in this
- Hydrological data – the system should be able to track upstream hydrological changes (e.g. increased flow), as well as downstream real-time usage and needs (see details below)
- Piezometric data – the consultant should provide for the use of a minimum of ten piezometric measurement systems in strategic locations in order to assess groundwater status
- Agricultural needs: the system should provide for monitoring of irrigation needs downstream
- Wetland needs: the system should take into account the requirements of the various wetlands to be able to provide the necessary levels of ecological services and maintain biodiversity. involve the needs of wetlands through the development of a systematic water level monitoring system (environmental flows)
- Water quality – the system should provide alerts for changes in water quality in real-time or near real-time

Importantly this system should take into consideration the interconnected nature of all elements of the system and should be costed. The ability to manage remotely is an added bonus. Implementation of some aspects should start at the beginning of Year 5 in order to support the implementation of infrastructure coming on line (such as TAMS/Geba).

Task 2: Capacity-building

The consultant should carry out a capacity needs assessment with respect to all aspects of operationalisation of the proposed system. This is then to be followed by the development of an appropriate capacity building programme to ensure that the system can be operationalised.

PHASE 3: IMPLEMENTATION OF OPERATION AND MANAGEMENT SYSTEM

Task 3: Piloting and validation

As the first elements of infrastructure come on line, starting with the TAMS Dam and associated multipurpose sub-components, and especially the hydropower sub-component it will be possible to pilot the operation and management system basinwide. This will also be an opportunity to provide training on the system.

3.1.3 Component 1C: Institutional Framework

The objective of this task is to design institutional arrangements for the overall programme, taking into account the inter-sectoral and transboundary implications.

3.1.4 Component 1D: Monitoring and Evaluation System

The Consultant will prepare a monitoring and evaluation system. The main aim of this system will be to check whether the operation and management system is having the desired effects.

3.2 COMPONENT 2: CORE INFRASTRUCTURE COMPONENTS

3.2.1 Component 2A: Tams Hydropower Scheme

This component is focused on the development of the TAMS Dam and the associated hydropower scheme. While the primary purpose of the component is concerned with the generation of hydropower, it is important that the dam and reservoir is seen as a component of the overall system, providing i) multipurpose opportunities directly associated with the reservoir and ii) associated with the way in which it can modify the downstream flows in the Baro and Sobat Rivers. The design of the Dam will therefore, also have to take into account the multipurpose needs identified under Component 3 as well as the operational requirements defined, as outputs of Component 1

All preparatory work concerned with the collection of available studies and assessment of the current status of the project will have been completed as part of the overall programme Inception and Scoping Phase. This will **include at least (see footnote) a detailed review of the ongoing/existing[2] feasibility study/ESIA for the TAMS Dam in the context of the overall integrated development programme**.

PHASE 1: REVIEW / UPDATING / UPGRADING OF THE FEASIBILITY STUDY AND ASSOCIATED ESIA

Based on the review carried out during the Inception and Scoping Phase, the existing feasibility study report, design and drawings for the TAMS Dam and appurtenant works will be reviewed in detail and updated as necessary to ensure that the design will adequately take into account the context of the overall integrated development programme. All relevant information will be assessed to establish whether or not additional information and investigations are required. In particular this should take into account i) the transboundary perspective and ii) opportunities for multipurpose water resources development opportunities.

This will also include review and updating of the existing Environmental and Social Impact Assessment (ESIA). It will include an assessment of the potential positive and negative impacts of the projects and proposition of i. avoidance/enhancement ii. reduction iii. Mitigation iv. Offset measures. These measures should be costed. The consultant is strongly suggested to subcontract this study partially or in full in order to ensure objectivity towards the proposed design. In this case, the client must approve of the sub-contractor, and the consultant must ensure that all data previously collected, study outputs, and maps be at full disposal.

The existing Feasibility Study will be updated to a full comprehensive investigation at feasibility level. Key tasks will include but are not limited to the following:

Task 1 - Review of Existing Studies/Reports

The Consultant shall, immediately upon initiation of the assignment, start with the collection of all information, reports, data and mapping relating to the current project. The Client will make available to the Consultant existing relevant documentation on the project.

Task 2 - Field Reconnaissance

The Consultant shall undertake a field reconnaissance during the early stages of the assignment in order to become familiar with the project area and to gain a first-hand impression of all hydrological, geological, topographical and geographical features and environmental conditions which might affect the feasibility and cost of the dams and associated structures. The Consultant shall include all key and senior members of his team with the necessary skills and experience in the reconnaissance visit. During the field visit, potential environmental and socio-economic impacts (both positive and negative)

2

associated with the proposed project will also be identified. These typically relate to biodiversity, land use, potential health risks, tourism potential, etc.

Task 3 - Water Resources Assessment

A hydrological study should be conducted aimed at updating and refining the existing hydrology of the sub-basins upstream of the proposed dams. This should involve deterministic approaches based on readily available hydrometric and meteorological data and existing and future land use and water requirements in the catchment. The objective of this task is to simulate long-term inflow sequences into the respective dams to inform the yield analysis as well as subsequent economic analyses and the optimisation of operating rules. Climate change, land use and water use scenarios should also be considered. A yield analysis should be conducted to confirm the size (storage volume) of the dam, which would be required to meet all of the demands on the dam at an acceptable level of assurance. A first order environmental flow determination also needs to be undertaken for the rivers downstream of the dams.

Task 4 - Sedimentation

The Consultant shall review previous sedimentation studies and use empirical and/or deterministic approaches to estimate the sediment load into the dams and the associated loss in storage volume over the next 100 years, taking into account existing and future land use characteristics in the catchments upstream. Grab samples of sediment need to be collected in order to supplement the limited data which is currently available.

Task 5 - Geotechnical Investigations

The Consultant shall review the available geotechnical information in the existing feasibility studies and conduct additional investigations to enable the optimisation and costing of the dam types. The investigation which will have to be completed to feasibility level at the dam sites and quarry areas include sufficient foundation investigation, construction material, investigation, geotechnical investigation and specific investigations for the related facilities (access roads, construction village etc.).

The Consultant's investigations and testing, together with results of previous geotechnical investigations, must be sufficient to enable detailed design of the dams, foundation treatment, and appurtenant structures. The studies shall enable an accurate definition of site geology and provide information on rock lithology, depth and degree of weathering, structural geology and groundwater. They shall outline the limits of potentially unstable rock. The Consultant shall provide engineering parameters for quantifying strength, deformability and permeability of the foundations. Sources of construction material shall be studied, together with laboratory testing and determinations of their durability and physical properties. The Consultant shall study the groutability of the bedrock foundations for use in a grout curtain and consolidation grouting designs. The Consultant shall also be responsible to review and confirm the suitability and availability of rockfill material (if applicable) and proving of quarry sites for material suitable for use as concrete aggregates.

The proposed geotechnical investigations and testing to be conducted at or in the vicinity of the proposed dam site and quarry sites shall include but are not limited to core drilling, seismic refraction survey and sand sampling.

As an addition to the orientated core and normal logging which would be performed during core drilling, it is a requirement that geophysical down-the-hole evaluation is also conducted. Core holes will be water pressure tested at multiple levels to enable a meaningful grouting design to be undertaken for the dam. For the quarry sites this will enable an evaluation of the in situ integrity of the deposit to be established and give an indication if any of deleterious zones. Cores will be retrieved from the drilling to enable rock testing and concrete aggregate testing.

In order to supplement the core retrieval data and stitch the data obtained from the corehole investigation together to form the geological model over the extended dam footprint, spillway and the proposed quarry areas, it is envisaged that seismic refraction surveys be conducted.

Sand for concrete aggregate may well be most economically retrieved from sources on the river and 5 sites are to be investigated. Sand samples shall be obtained, checked for the presence of precious stones, and forwarded to the laboratories for testing in accordance with relevant standards. Should precious stones be found, the Contractor shall deliver such stones to the Commissioner or person in charge of the nearest police station.

Task 6 - Seismicity studies

The Consultant shall plan and execute a probabilistic seismic hazard analysis and review previously undertaken studies to determine the seismic design parameters for the dams and appurtenant structures. The study shall establish the degree of earthquake hazard for the project area, appropriate attenuation relationships and ground motion parameters at the dam site. This data shall be used in dam stability analyses, as discussed in Task C.

Task 7 - Reservoir and Reservoir Rim Geological Studies

The Consultant shall plan and execute a programme of reservoir and reservoir rim geologicalstudies. These studies, will provide input data for various project design tasks and will, inter alia, review the following:

i. the distribution of bedrock and surficial structural geology
ii. groundwater occurrence and profiles
iii. the occurrence of mineral resources
iv. identification and analysis of landslides and evaluation of reservoir rim stability
v. an evaluation of reservoir triggered seismicity and consequential impacts
vi. reservoir integrity and water tightness

It is anticipated that the above items can be studied by means of published data, aerial photographs and walk-over studies. Further investigations, such as boreholes, test pits or geophysics, may be considered if needed to explore specific features identified by the studies.

As a consequence of the steep slopes, the reservoir rim study is particularly important and the reservoir rim studies must include a specific review with stereo-photos to identify any existing / historical landslides. With regard to reservoir triggered seismicity, probabilistic analysis may be less meaningful, and particular emphasis on deterministic evaluations may be necessary.

Geological, Geotechnical and Materials Report: Upon completion of Tasks 5 to 7, the Consultant shall submit a comprehensive report containing the results of the geotechnical investigations, seismicity studies and laboratory testing of materials relating to the work. The report shall also include the results of the geotechnical investigations undertaken in other studies that are relevant to the tender design so that a comprehensive record of investigations is available. The report shall be included in the Tender Documents for the TAMS Dam and appurtenant works to provide the Ground Reference Conditions. The reporting of all results, regardless of the source, shall be based on common terminology. The report shall include plotted profiles based on all drill holes, the results of all field and laboratory tests, and a full account of the analysis and evaluation of the results. Borehole logs, test pit logs and other documents containing geotechnical data shall be presented in a format approved by the Client. The definitions, classifications, nomenclature and symbols used in other investigations and the Consultant's investigations shall be identical.

Task 8 – Topographic Survey

The Consultant shall undertake a topographic/Lidar survey at the locations of the TAMS dam site and appurtenant structures, quarry sites and dam basin. The survey data shall be utilised for preliminary and tender design of the works. The Consultant shall provide sufficient survey reference data at the site to allow the contractor to set out the works. Within all areas where proposed works may affect the public, the Consultant shall identify and accurately survey all structures, properties, cultivated and grazing lands and record their respective owners. The Consultant shall issue the recorded information to the Client continuously through the survey process. The format of the submitted information shall be compatible with the Client's software.

Task 9 - Preliminary Engineering Design

Based on the existing feasibility study, supplemented by the above tasks, the Consultant will prepare preliminary design drawings and details for the dam and ancillary structures, the hydropower scheme and any structural elements that may be required to cater for associated multipurpose water resources development opportunities. The Consultant will optimise and finalise the layout and configuration of the dam and its appurtenant works.

Key tasks to be addressed as part of the Preliminary Engineering Design include:

Sub-task 9-1: Design Flood Analysis
To ameliorate the uncertainty associated with flood determination, a combination of different design flood analysis techniques should be applied including probabilistic, empirical and deterministic techniques. The deliverables for this task will consist of updated recommended flood peaks for different probabilities of exceedance as well as recommend flood hydrographs. Currently accepted norms as promulgated by the International Committee on Large Dams (ICOLD) will be used in selecting a Recommended Design Flood (RDF) and a Safety Evaluation Flood (SEF) for the purpose of designing the dam spillway. These will take the proposed height of the dam and the hazard rating (potential impact on life and property in the event of a failure) into account.

Sub-task 9-2: Hydraulic analysis
The Consultant shall assess hydraulic conditions associated with the spillway, low level outlet, diversion, compensation release and small-hydro. These studies shall include but not be limited to cavitation, scour potential, intake submergence, hydraulic stability, hydrodynamic vibration, energy dissipation, unfavourable flow patterns, air venting, drainage and sediment transport and exclusion, as required. The Consultant shall prepare the hydraulic design of structures on the basis of numerical analysis and experience of similar structures on other projects. Where necessary, the Consultant shall also conduct physical model studies to verify the hydraulic design, subject to the approval of the Client.

Sub-task 9-3: Dam Design

The Consultant shall undertake a review of the dam design and general arrangement presented in the Feasibility Study. If deemed critical, other dam types may be considered by the Consultant. The objectives of the Consultant's studies will be to finalise layout concepts in a manner as to reduce the overall cost of the dam, if possible, and to improve the technical performance, ensuring the water tightness of the structure over a projected 100 year lifespan, without any requirement for major rehabilitation.

Issues to be dealt with by the Consultant, considering current best practice, shall include but not be limited to the following (as applicable):

i. Examine the dam wall structure with regard to geometry and materials to ensure durability and economy.

ii. Examine overall design parameters, including crest width, freeboard, external slopes, concrete slab thickness, jointing etc.

iii. Examine grout curtain layout, depth of foundation excavation and foundation treatment aspects of the dam.

iv. Study and optimize dam layout and final alignment within the designated site area in conjunction with other studies and project components.

v. Review and optimize the programming of the dam with consideration to programming of river diversion and reservoir impounding.

In addition to the above, the Consultant shall undertake all other necessary studies to finalize layout features of the dam and confirm the technical feasibility of the recommended design. Preliminary drawings of all alternative arrangements shall be prepared to show design features to take off quantities and to develop comparative cost estimates to a level appropriate for the selection of the best alternative. The most promising arrangements shall be discussed with the Client, as and when

appropriate, and in any event before they form the basis for more detailed studies. Cost alone will not be the determining factor in selecting arrangements.

Sub-task 9-4: Spillway Arrangements

The Consultant shall re-examine the spillway design as proposed during the Feasibility Study. The Consultant shall conduct an in-depth assessment, including numerical and/or physical model testing to determine the optimum location and arrangement of the spillway. The assessment shall also examine alternative arrangements for intake structures, discharge facilities and chute and energy dissipation. This work will establish the comparative costs of each arrangement and determine any reduced or increased rock fill volumes excavated from the different alternatives. The Consultant shall determine the overall impact of these reduced or increased volumes on the cost of the dam.

Arrangements shall be prepared to show design features, to take off quantities and to develop cost estimates to an appropriate level to make a selection of the best alternative. The most promising arrangements shall be discussed with the Client, as and when appropriate.

Sub-task 9-5: River Diversion and Management

The Consultant shall review and optimise the River Diversion and Management design as proposed during the Feasibility Study. The review shall include consideration of risks associated with diversion floods during dam and appurtenant structure construction. Alternative arrangements shall be carefully examined to determine the optimal scheme in terms of cost, risk, hydraulic performance and constructability. Preliminary drawings of all alternative arrangements shall be prepared in sufficient detail to show design features, to take off quantities and to develop comparative cost estimates at appropriate levels to make a selection of the best alternative. The most promising arrangements shall be discussed with the Client.

Sub-task 9-6: Outlet Works

The Consultant shall review the outlet work facilities as recommended in the Feasibility Study. The Consultant shall then develop and optimise the outlet work facilities based on the preliminary designs of the dam and the river diversion and management requirements, and the dam construction programme. The Consultant shall ensure that the design of the outlet works complies with applicable dam safety requirements, environmental flow requirements and operations and maintenance requirements. Preliminary drawings of all alternative arrangements shall be prepared in sufficient detail to show design features, to take off quantities and to develop comparative cost estimates at appropriate levels to make selection of the best alternative. The most promising arrangements shall be discussed with the Client.

Sub-task 9-7: Hydro Power Station

The Consultant shall undertake the feasibility study and design of the hydro power station. The sizing of the hydro power station shall be optimized on the basis of the environmental flow releases and reservoir operating rules (see Componentb1). The pattern of the releases shall be discussed and agreed with the Client prior to undertaking any studies. The services shall provide for a plant of one or two units each with all the necessary mechanical and electrical equipment.

Sub-task 9-8: Works Areas and Camps, Location and Requirements

The Consultant shall review the requirements for his own site facilities and for the contractor's works areas, quarries, labour camps and other facilities, with estimates of power, water supply, solid waste management and waste water treatment demands. This information shall be provided to the Project Housing and Associated Infrastructure consultant and the Bulk Power and Telecommunications consultant for their planning purposes.

Sub-task 9-9: HAZOP Study

The Consultant shall carry out a hazard and operability study (HAZOP study) on the Preliminary Design.

Sub-task 9-10: Constructability Review

The Consultant shall carry out a constructability review of the Preliminary Design. The Consultant shall evaluate and prepare construction requirements with emphasis on constructability, construction sequencing and material handling aspects. Any climatic influences, external and internal influences affecting construction activities and scheduling such as quarry operations, construction equipment and processes, work force skills and productivity shall be addressed. The Consultant shall give special consideration to the procedures as they pertain to hazards that affect the work site during construction.

Sub-task 9-11: Cost estimate

Construction cost estimates for the proposed dam type will be prepared. The Consultant needs to indicate the information used, the accuracy of the estimates and possible impacts on final costs due to uncertainties in available information. Sufficient attention needs to be paid to project-related infrastructure such as temporary works, permanent access roads, power supplies, site buildings etc.

Sub-task 9-12: Preliminary Design Report, Cost Estimate and Construction Programme

The Consultant shall prepare a Preliminary Design Report with drawings summarizing the findings of his investigations and studies for all the works under this scope and presenting and motivating the final arrangement of the scheme, including the detailed design criteria to be adopted during the Tender and Construction Designs.

The Consultant shall prepare a Cost Report based on the Preliminary Design.

The Consultant shall prepare a Preliminary Construction Programme for the construction work and pre-construction engineering activities (design, tendering, mobilisation and activities by others), using critical path methods, relating this Programme to the expected construction methods and showing:

i. duration of all major activities
ii. milestone dates for major events
iii. the critical path

The Consultant shall prepare a preliminary designer's health and safety report including a 'baseline risk assessment', in accordance with the requirements of the relevant authority.

Deliverable: Comprehensive Feasibility study for the TAMS multipurpose dam (month 12)

Workshop 3: Presentation of the feasibility study for the TAMS multipurpose dam to be taken to design[3] (month 12.5)

PHASE 2: DESIGN STUDY AND PREPARATION OF TENDER DOCUMENTS

Under this task, the Consultant will prepare tender designs and documentation in line with international standard guidelines and incorporating both Health and Safety and Environmental aspects.

Task 1 - Updated EMP and Compilation of Environmental Specifications

The Environmental and Social Impact Assessment (ESIA), including a draft Environmental Management Plan (EMP) will be prepared. This work will be carried out partly in parallel with the

[3] **Additional workshops that may be required should be proposed by the Consultant in his methodology.**

engineering design services. The Consultant shall therefore liaise closely with the ESIA consultant during the design period, and incorporate the EMP into the Tender documents as it is made available. The Environmental Manager shall critically review the environmental mitigation and monitoring measures contained in the EMP and revise such measures as deemed necessary. The Environmental activities shall be undertaken in accordance with relevant legislation and policies, supplemented where appropriate with reference to internationally recognised standards.

The Consultant shall prepare environmental specifications, using the draft EMP, and subsequently the approved EMP, for inclusion in tender documents, to ensure that all potential negative impacts are mitigated. The specifications shall include contractual penalties for any environmental damage caused on site, or non-compliance with the Environmental Specifications. The consultant shall identify those aspects of the works (not identified during the ESIA process) which have potential negative environmental impacts, and include appropriate measures to mitigate these effects in the revised EMP.

Task 2 - Compilation of Environmental Baseline (Natural and Social)

The Consultant shall undertake the following tasks:

i. Define the scope and detailed specification for the establishment of an Environmental Baseline against which the contractor shall be required to monitor. This baseline will form the basis for the environmental control parameters in the Specification. Typical variables for which an environmental baseline is required include water quality, ambient dust, ambient noise, traffic volumes and waste (where applicable).

ii. Establish an independent environmental baseline before commencement of construction. Monitoring of environmental parameters potentially affected by construction shall be carried out over a sufficient time period to identify the annual variation in each parameter where practicable. Monitoring shall be sufficient to establish a baseline for all areas (streams, communities, other affected locations) directly impacted by the Project.

iii. Develop a record of all activities, land uses and structures situated within approximately 50 metres of the site boundary(ies). The purpose of the record is to identify specific land uses and structures adjacent to the site boundaries where special arrangements may need to be agreed with land owner(s) to ensure good project relations. Where activities such as blasting may affect neighbouring property owners over a wider area, the area recorded shall be extended appropriately.

iv. The Consultant shall prepare a record of all assets and or infrastructure potentially affected by the Project, for the future assessment of construction impacts on assets not covered by the Resettlement Action Plan. This will include a photographic record and GPS co-ordinates of each asset. The Resettlement Consultant(s) will prepare a detailed record of all assets involved in the resettlement process (those permanently lost due to the Project). They will not address other assets (properties, infrastructure and so on) which may be affected during construction but not be due for expropriation.

v. The Consultant shall prepare an Environmental Baseline Report, recording the results of sub-tasks i) to iv) above.

Task 3 - Support Services to the Client

The Consultant shall undertake the following tasks:

i. Identify all permanently and temporarily impacted land portions, compile a Schedule of Impacted Land Portions, and compile maps and drawings per affected cadastral portion. The Consultant should specify when access to the land portions is required for construction purposes. This information is to be provided within 3 months of commencement of the Contract.

ii. Compile an access protocol on how to interact with impacted land owners/occupiers. The Protocol will be submitted to the Client for approval.

iii. Provide ongoing support to the Client for land acquisition. The Consultant shall inform the Client of instances where detailed design resulted in significant changes to the access

requirements of permanent and temporary land portions. Note that the actual process of land acquisition and resettlement will be managed by the Client through the Resettlement Consultant(s) under other contracts.

Task 4 - Tender Design

To provide the Services for this stage the Consultant shall assemble team(s) of engineers and other specialists, experienced in the conceptual, tender, detailed design and documentation of large dams and appurtenant works. In addition, the team(s) shall be experienced in geological and geotechnical investigation, testing and analysis, hydraulic design, dam design, structural design, civil works design, electrical and mechanical design, cost estimating and programming, construction methodology development and environmental monitoring. The Consultant shall provide the Services, carry out such duties and assume such powers and responsibilities as are defined in this Contract, and as are necessary for the due performance of the Services.

Based upon the approved Preliminary Design and utilizing the survey data and any further geotechnical data, the Consultant shall prepare tender designs. The Consultant shall undertake their structural designs in compliance with state of the art practice and internationally recognized and applicable local codes and standards. The designs shall conform to and be suitable for the site conditions, and shall use locally available materials and labour to the greatest extent possible. They shall aim to achieve minimum overall cost without adversely affecting the environment, the health of the workers, or the safety, security, efficiency or longevity of the Works. Convenience of operation including remote control shall be considered. The permanent works equipment shall be designed to be readily maintained with locally available spares wherever practicable.

The Tender Design and preparation of tender documents shall be to a level that will allow construction design to proceed without the need for further field investigations and without major changes to the tender design. Should unexpected subsurface conditions arise, the study activities shall be reviewed and an approach to deal with the conditions shall be proposed by the Consultant. Such approach shall be subject to the approval of the Client.

The Tender Design process shall include the following sub-tasks:

Sub-task 4-1: Design Basis Memorandum

The Consultant shall formulate a Design Basis Memorandum (DBM) setting out in detail the criteria, assumptions and parameters to be used in the Tender Design, ensuring compliance with state of the art practice and internationally recognized and applicable local codes and standards. This work shall include such items as loading cases, factors of safety, allowable stresses, seismic design criteria, stability criteria, allowable loading, acceptable and appropriate standard details, minimum materials and operational requirements, instrumentation monitoring requirements and all other factors necessary for the Tender Design. The memorandum shall include methodologies for the application of the criteria in the Tender Design and will define the design approach, the analysis steps and development and the various computer software programs to be applied for the analyses and for all Tender Design work. The DBM shall be submitted to the Client for comment and acceptance.

The Consultant shall advise the Client on any special surveys, data collection activities, sampling, laboratory tests and analyses, or other tests that may be needed for completion of the tender design. After agreement of the Client to the need for such work, the Consultants shall draw up specifications and assist the Client with procuring the necessary services.

Sub-task 4- 2: TAMS Dam and Appurtenant Works Design

The Consultant shall design the Works taking into consideration information from the above tasks and any additional information from any other source. The design shall be carried out to a level of detail sufficient for international tendering and will address the dam, ancillary works, water treatment plants, bulk pipelines, canals etc.. For all significant structures and elements, this work shall include, but not be limited to, the complete design of hydraulic structures, foundation treatment and grouting,

instrumentation, seepage analysis, stability, deformation and stress analysis and architectural work and finishing.

The analysis and design of the dam must demonstrate to the Client that cracking, excessive settlement in any direction and unexpected seepage/leakage will not occur at any stage during the dam construction, impoundment and operation.

All Tender Design investigations, reports and drawings must be prepared to an adequate level to allow Tenderers to easily understand the requirements of the proposed works, to understand the proposed construction and accordingly, to accurately resource, programme and price all scheduled items of work.

In the case of reinforced concrete, sufficient structural calculations shall be made to justify the concrete dimensions and the quantities of reinforcement. The arrangement of bars shall be considered in sufficient detail to ensure that their placement is technically feasible and economic and that indicative reinforcement drawings can be developed, showing the nature of the construction work involved. Detailed reinforcement drawings and bar lists will not be required to be prepared by the Consultant for the Tender Documents.

The designs shall conform to and be suitable for the site conditions and shall use locally available materials and labour to the greatest extent possible. They shall aim to achieve minimum overall cost without adversely affecting the environment, the health of the workers, or the safety, security, efficiency or longevity of the Works. Convenience of operation including remote control of equipment shall be considered.

The Tender Design and preparation of Tender Documents for civil and electromechanical works will be based as far as possible on standardized manufacturer's equipment and shall consist of justification of the choice of the equipment, operating conditions and the main design criteria. Information regarding the design of the Small Hydro shall be included in the Tender Design Report.

The Consultant shall provide complete designs for the mechanical and electrical systems, drainage, lightning, etc. for the above items and shall specify the components required for these systems.

For the major items of mechanical and electrical equipment such as gates, valves, bulkheads, etc., the Consultant shall define the outline design and specify performance characteristics of the equipment in sufficient detail for the equipment suppliers to undertake detailed design and manufacture.

The Consultant shall prepare all necessary documents as required by internationally recognized standards on the safety of dams which include:

i. A construction supervision and quality assurance plan
ii. An instrumentation plan
iii. An operation and maintenance plan
iv. An emergency preparedness plan

In addition, the Consultant shall also carry out dam break studies to establish the potential inundation area downstream of the dam. Inundation mapping, at an appropriate scale, shall be prepared to define the area of risk.

The Consultant’s Tender Design shall include all components of the permanent works and all work within the design scope and the scope and cost shall not be reduced by passing inappropriate design responsibility to the contractor.

Sub-task 4-3: Construction Infrastructure – Access Roads, Quarries, Works Areas, Layout and other requirements

The Consultant shall prepare preliminary layout designs of site access roads, quarries, construction yards and works areas sufficient for tender purposes. All local construction access roads and services will be within the dam contractor's scope.

The Consultant shall identify site establishment requirements and the need for any additional road(s) outside the Permanent Access Roads. Site roads shall include possible contractor's roads to quarries, spoil areas or other work locations. The consultant shall liaise with Urban planners/Architects in the selection of appropriate works areas. Detailed design of temporary construction infrastructure shall be the responsibility of the relevant contractor.

The Consultant shall estimate the power requirements of the contractor and advise the Client. The Consultant shall describe the construction power system in the Tender Documents so that the contractors can cost and design any electrical connections and protection arrangements required for the construction.

The Consultant shall address the water supply and treatment for potable use at the construction site in the Tender Documents.

Sub-task 4-4: Trial Blasting and Trial Embankments

The Consultant shall plan a programme of trial blasting of test quarries and construction of trial embankments to be carried out at an early date during the construction contract to enable optimization of the construction design. The programme and detailed requirements shall be included in the Tender Documents.

The Consultant's test programme shall include, but not limited to the following elements:

i. trial blasting of quarries,

ii. trial embankments which investigate the effects of layer thickness, compaction effort, rock fill gradations and sluicing for rock fills,

iii. comparison of field compaction trials to laboratory compaction testing of modelled rock fills.

The Consultant shall also take note of durability testing carried out during the feasibility study.

Sub-task 4-5: Concrete Mix Designs

The Consultant shall undertake the design of concrete mixes for each of the grades of concrete to be utilised in the structural designs. The Consultant shall undertake statistically valid testing to prove his designs.

Sub-task 4-6: - Designer's Health and Safety Report and Specifications

The Consultant shall update the 'baseline risk assessment', produce site specific health and safety specifications and produce the designer's Health and Safety Report in accordance with the requirements of the relevant authorities, policies and legislation. In particular a coherent system of formal appointments, responsibilities and accountabilities shall be specified to ensure that those who are actively in authority over the workforce are accountable for the workers' safety. Where appropriate the Consultant's project staff shall be included in the appointments structure.

The Occupational Health and Safety provisions shall be on the following basis:

i. The contractors will have primary responsibility for the occupational health of their own workforce, including annual health screening, first aid, general medical care, health education and emergency medical response. The contractors are to provide occupational health facilities on site. These resources will be made available to the Engineer's and Client's staff associated with that contract.

ii. The contractor will provide emergency response (ambulance, paramedic, medical stabilisation) for major incidents, including helicopter landing facilities at each major site for emergency evacuation.

iii. The contractor will provide an emergency response team, either through training and equipping their own staff, or by contract with a regional support team.

The Consultant shall liaise with the consultant for the Public Health Action Plan (PHAP) and the consultants for the other major engineering packages to identify the appropriate off-site facilities for major medical treatment (local clinics, district hospitals or regional hospitals).

The Consultant shall liaise with the consultants for the other major engineering packages to determine the practicality of standardizing core safety policies across the project (for example alcohol testing, traffic offences, 'zero tolerance' issues). An access control system shall be implemented by the contractor to manage construction site and tunnel portal entry and exit. A database recording safety induction, driver status, medical, blacklisting etc. shall be maintained for all personnel on site.

Sub-task 4-7: - Compilation of Tender Design Report

Technical Memoranda: At pre-determined milestones throughout the Tender Design process, the Consultant shall submit technical memoranda on particular parts of the work. The Consultant shall identify such milestones in his Baseline Programme developed under Sub-Task C1. Each memorandum shall set out the concepts, methods, criteria and key parameters used in design, the results of design calculations, a clear discussion of the reasoning behind the technical decisions involved, indications of related matters still to be settled, and a brief account of the implications for costs and programming. These reports shall be submitted as soon as possible after work performed for specific items.

Tender Design Report: The Consultant shall submit a self-contained report describing the tender design, consolidating the information covered in previous submissions, with any revisions made in the course of discussion, review and refinement. The contents of the Tender Design Report shall include but not necessarily be limited to the following:

i. methods used in design;

ii. reasons for technical decisions;

iii. indicative construction programme;

iv. details of further design work required during construction, with recommended methods and criteria;

v. reference to all technical memoranda and other design reports;

vi. design sketches and drawings and calculations in appendices; and

vii. link with cost estimate.

The report shall be prepared and issued initially as a draft report for review by the Client. It shall include the results of all studies and investigations, with tables and drawings and it shall, after review and incorporation of all queries and acceptance by the Client, be re-issued in final form.

Sub-task 4-8: - Prepare Tender Documents, Engineer's Programme and Cost Estimate

The Consultant shall produce Tender Documents for a contract for the construction, supply and installation of equipment and commissioning of the Works, including maintenance of Project access roads, which shall be in accordance with the FIDIC Tendering Procedure Guidelines and the Client's Contractor Procurement Strategy. The Consultant shall discuss in detail with the Client the extent to which tenderers should be permitted to suggest alternative designs, construction methods, or temporary works.

The Consultant shall review the scope of work provided under this contract and:

i. identify the interfaces required with others

ii. identify additional items to be provided by others for the proper execution of the contract

iii. assist the Client in identifying construction-in-progress assets for inclusion in a master asset registry

The Consultant shall also consider the physical, programme and contractual interface between the main works and other contracts to minimise the potential for disruption, delays or claims by either contractor.

The documents shall describe the Works, including temporary works as necessary, in sufficient detail to allow tenderers to confidently determine their cost of construction, and ensure the receipt of comparable tenders.

The Tender Documents shall include and will not be limited to the following:

i. Drawings, sufficient for tender purposes

ii. Bill of Quantities (BoQ), in accordance with a recognised standard method of measurement of civil engineering works, which shall include sufficient items to enable the evaluation of design modifications and other variations

iii. Technical Specifications, including requirements for environmental protection and health and safety

iv. Conditions of Contract, using the FIDIC 'Conditions of Contract for Construction for Building And Engineering Works Designed By The Employer, Multilateral Development Bank Harmonised Edition, June 2010' (FIDIC). These shall include requirements for the management of construction programmes based on the Delay and Disruption Protocol issued by the Society of Construction Law (www.scl.org.uk) and local procurement preference.

v. Factual information, including Geological, Geotechnical and Materials Report

vi. All associated documentation for the complete Tender process

vii. Engineer's Programme. This shall include the construction work and pre-construction engineering activities (design, tendering, mobilisation and activities by others) using critical path methods, relating this Programme to the expected construction methods, and showing at least:
   - duration of all major activities;
   - logic linkages (e.g. Finish to Start);
   - work breakdown structure;
   - resources allocated against all major activities;
   - interfaces with other contracts (deliverables and receivables);
   - milestone dates for major events;
   - the three most critical paths and extent of criticality involved; and
   - proposed measures to mitigate potential delays.

The Consultant shall demonstrate that the indicative programme fits into the overall construction programme and satisfies the Client's requirements. The programme shall be formulated in sufficient detail to facilitate preparation of realistic cost estimates.

The Consultant shall produce the Engineer's Estimate of construction costs, which shall include the projected cost together with the Consultant's indication of areas of uncertainty (risk). The Engineer's cost estimate shall include a resource based cost estimate, using the Engineer's Programme, and comparison with a Bill of Quantities based estimate. The cost estimate must be suitable for presenting to international financing agencies and/or organisations such as commercial banks and export credit groups. The format is to be discussed with the Client. Cash flows shall be prepared from the cost estimates and shall include the effect of contract price escalation. The cash flow shall also take into account the effect of any advance payments, interim valuations, retention, etc.

Under this task the Consultant shall print and bind the documents and shall provide the Client with a number of copies as specified.

Deliverable: Design studies and tender documents for the TAMS multipurpose dam

Workshop 4: Presentation of the design study for the TAMS multipurpose dam for validation and finalisation

3.2.2 Component 2B: Geba Reservoir and Diversion Systems

This component is focused on the development of the Geba Dam and reservoir and its associated diversion systems. While the primary purpose of the component is concerned with the generation of hydropower, it is important that the dam and reservoir is seen as a component of the overall system, providing i) multipurpose opportunities directly associated with the reservoir and ii) associated with the way in which it can modify the downstream flows in the Baro and Sobat Rivers.

All preparatory work concerned with the collection of available studies and assessment of the current status of the project will have been completed as part of the overall programme Inception and Scoping Phase.

This will include a detailed review of the existing feasibility study for the Geba Dam in the context of the overall integrated development programme.

The existing Feasibility Study will be updated to a full comprehensive investigation at feasibility level.

Key tasks will include but are not limited to the following:

Task 1 - Review of Existing Studies/Reports

The Consultant shall, immediately upon initiation of the assignment, start with the collection of all information, reports, data and mapping relating to the current project. The Client will make available to the Consultant existing relevant documentation on the project.

Task 2 - Field Reconnaissance

The Consultant shall undertake a field reconnaissance during the early stages of the assignment in order to become familiar with the project area and to gain a first-hand impression of all hydrological, geological, topographical and geographical features and environmental conditions which might affect the feasibility and cost of the dams and associated structures. The Consultant shall include all key and senior members of his team with the necessary skills and experience in the reconnaissance visit. During the field visit, potential environmental and socio-economic impacts (both positive and negative) associated with the proposed project will also be identified. These typically relate to biodiversity, land use, potential health risks, tourism potential, etc.

Task 3 - Water Resources Assessment

A hydrological study should be conducted aimed at updating and refining the existing hydrology of the sub-basins upstream of the proposed dams. This should involve deterministic approaches based on readily available hydrometric and meteorological data and existing and future land use and water requirements in the catchment. The objective of this task is to simulate long-term inflow sequences into the respective dams to inform the yield analysis as well as subsequent economic analyses and the optimisation of operating rules. Climate change, land use and water use scenarios should also be considered. A yield analysis should be conducted to confirm the size (storage volume) of the dam, which would be required to meet all of the demands on the dam at an acceptable level of assurance. A first order environmental flow determination also needs to be undertaken for the rivers downstream of the dams.

Task 4 - Sedimentation

The Consultant shall review previous sedimentation studies and use empirical and/or deterministic approaches to estimate the sediment load into the dams and the associated loss in storage volume over the next 100 years, taking into account existing and future land use characteristics in the catchments upstream. Grab samples of sediment need to be collected in order to supplement the limited data which is currently available.

Task 5 - Geotechnical Investigations

The Consultant shall review the available geotechnical information in the existing feasibility studies and conduct additional investigations to enable the optimisation and costing of the dam types. The investigation which will have to be completed to feasibility level at the dam sites and quarry areas include sufficient foundation investigation, construction material, investigation, geotechnical investigation and specific investigations for the related facilities (access roads, construction village etc.).

The Consultant's investigations and testing, together with results of previous geotechnical investigations, must be sufficient to enable detailed design of the dams, foundation treatment, and appurtenant structures. The studies shall enable an accurate definition of site geology and provide information on rock lithology, depth and degree of weathering, structural geology and groundwater. They shall outline the limits of potentially unstable rock. The Consultant shall provide engineering parameters for quantifying strength, deformability and permeability of the foundations. Sources of construction material shall be studied, together with laboratory testing and determinations of their durability and physical properties. The Consultant shall study the groutability of the bedrock foundations for use in a grout curtain and consolidation grouting designs. The Consultant shall also be responsible to review and confirm the suitability and availability of rockfill material (if applicable) and proving of quarry sites for material suitable for use as concrete aggregates.

The proposed geotechnical investigations and testing to be conducted at or in the vicinity of the proposed dam site and quarry sites shall include but are not limited to core drilling, seismic refraction survey and sand sampling.

As an addition to the orientated core and normal logging which would be performed during core drilling, it is a requirement that geophysical down-the-hole evaluation is also conducted. Core holes will be water pressure tested at multiple levels to enable a meaningful grouting design to be undertaken for the dam. For the quarry sites this will enable an evaluation of the in situ integrity of the deposit to be established and give an indication if any of deleterious zones. Cores will be retrieved from the drilling to enable rock testing and concrete aggregate testing.

In order to supplement the core retrieval data and stitch the data obtained from the corehole investigation together to form the geological model over the extended dam footprint, spillway and the proposed quarry areas, it is envisaged that seismic refraction surveys be conducted.

Sand for concrete aggregate may well be most economically retrieved from sources on the river and 5 sites are to be investigated. Sand samples shall be obtained, checked for the presence of precious stones, and forwarded to the laboratories for testing in accordance with relevant standards. Should precious stones be found, the Contractor shall deliver such stones to the Commissioner or person in charge of the nearest police station.

Task 6 - Seismicity studies

The Consultant shall plan and execute a probabilistic seismic hazard analysis and review previously undertaken studies to determine the seismic design parameters for the dams and appurtenant structures. The study shall establish the degree of earthquake hazard for the project area, appropriate attenuation relationships and ground motion parameters at the dam site. This data shall be used in dam stability analyses, as discussed in Task C.

Task 7 - Reservoir and Reservoir Rim Geological Studies

The Consultant shall plan and execute a programme of reservoir and reservoir rim geological studies. These studies, will provide input data for various project design tasks and will, inter alia, review the following:

i. the distribution of bedrock and surficial structural geology
ii. groundwater occurrence and profiles
iii. the occurrence of mineral resources
iv. identification and analysis of landslides and evaluation of reservoir rim stability
v. an evaluation of reservoir triggered seismicity and consequential impacts
vi. reservoir integrity and water tightness

It is anticipated that the above items can be studied by means of published data, aerial photographs and walk-over studies. Further investigations, such as boreholes, test pits or geophysics, may be considered if needed to explore specific features identified by the studies.

As a consequence of the steep slopes, the reservoir rim study is particularly important and the reservoir rim studies must include a specific review with stereo-photos to identify any existing / historical landslides. With regard to reservoir triggered seismicity, probabilistic analysis may be less meaningful, and particular emphasis on deterministic evaluations may be necessary.

Geological, Geotechnical and Materials Report: Upon completion of Tasks A5 to A7, the Consultant shall submit a comprehensive report containing the results of the geotechnical investigations, seismicity studies and laboratory testing of materials relating to the work. The report shall also include the results of the geotechnical investigations undertaken in other studies that are relevant to the tender design so that a comprehensive record of investigations is available. The report shall be included in the Tender Documents for the GEBA Dam and appurtenant works to provide the Ground Reference Conditions. The reporting of all results, regardless of the source, shall be based on common terminology. The report shall include plotted profiles based on all drill holes, the results of all field and laboratory tests, and a full account of the analysis and evaluation of the results. Borehole logs, test pit logs and other documents containing geotechnical data shall be presented in a format approved by the Client. The definitions, classifications, nomenclature and symbols used in other investigations and the Consultant's investigations shall be identical.

Task 8 – Topographic Survey

The Consultant shall undertake a topographic/Lidar survey at the locations of the GEBA dam site and appurtenant structures, quarry sites and dam basin. The survey data shall be utilised for preliminary and tender design of the works. The Consultant shall provide sufficient survey reference data at the site to allow the contractor to set out the works. Within all areas where proposed works may affect the public, the Consultant shall identify and accurately survey all structures, properties, cultivated and grazing lands and record their respective owners. The Consultant shall issue the recorded information to the Client continuously through the survey process. The format of the submitted information shall be compatible with the Client's software.

Task 9 - Preliminary Engineering Design

Based on the existing feasibility study, supplemented by the above tasks, the Consultant will prepare preliminary design drawings and details for the dam and ancillary structures, the hydropower scheme and any structural elements that may be required to cater for associated multipurpose water resources development opportunities. The Consultant will optimise and finalise the layout and configuration of the dam and its appurtenant works.

Key tasks to be addressed as part of the Preliminary Engineering Design include:

Sub-task 9-1: Design Flood Analysis

To ameliorate the uncertainty associated with flood determination, a combination of different design flood analysis techniques should be applied including probabilistic, empirical and deterministic techniques. The deliverables for this task will consist of updated recommended flood peaks for different probabilities of exceedance as well as recommend flood hydrographs. Currently accepted norms as promulgated by the International Committee on Large Dams (ICOLD) will be used in selecting a Recommended Design Flood (RDF) and a Safety Evaluation Flood (SEF) for the purpose of designing the dam spillway. These will take the proposed height of the dam and the hazard rating (potential impact on life and property in the event of a failure) into account.

Sub-task 9-2: Hydraulic analysis

The Consultant shall assess hydraulic conditions associated with the spillway, low level outlet, diversions, compensation release and small-hydro. These studies shall include but not be limited to cavitation, scour potential, intake submergence, hydraulic stability, hydrodynamic vibration, energy dissipation, unfavourable flow patterns, air venting, drainage and sediment transport and exclusion, as required. The Consultant shall prepare the hydraulic design of structures on the basis of numerical analysis and experience of similar structures on other projects. Where necessary, the Consultant shall also conduct physical model studies to verify the hydraulic design, subject to the approval of the Client.

Sub-task 9-3: Dam Design

The Consultant shall undertake a review of the dam design and general arrangement presented in the Feasibility Study. If deemed critical, other dam types may be considered by the Consultant. The objectives of the Consultant's studies will be to finalise layout concepts in a manner as to reduce the overall cost of the dam, if possible, and to improve the technical performance, ensuring the water tightness of the structure over a projected 100 year lifespan, without any requirement for major rehabilitation.

Issues to be dealt with by the Consultant, considering current best practice, shall include but not be limited to the following (as applicable):

i. Examine the dam wall structure with regard to geometry and materials to ensure durability and economy.

ii. Examine overall design parameters, including crest width, freeboard, external slopes, concrete slab thickness, jointing etc.

iii. Examine grout curtain layout, depth of foundation excavation and foundation treatment aspects of the dam.

iv. Study and optimize dam layout and final alignment within the designated site area in conjunction with other studies and project components.

v. Review and optimize the programming of the dam with consideration to programming of river diversion and reservoir impounding.

In addition to the above, the Consultant shall undertake all other necessary studies to finalize layout features of the dam and confirm the technical feasibility of the recommended design. Preliminary drawings of all alternative arrangements shall be prepared to show design features to take off quantities and to develop comparative cost estimates to a level appropriate for the selection of the best alternative. The most promising arrangements shall be discussed with the Client, as and when appropriate, and in any event before they form the basis for more detailed studies. Cost alone will not be the determining factor in selecting arrangements.

Sub-task 9-4: Spillway Arrangements

The Consultant shall re-examine the spillway design as proposed during the Feasibility Study. The Consultant shall conduct an in-depth assessment, including numerical and/or physical model testing to determine the optimum location and arrangement of the spillway. The assessment shall also examine alternative arrangements for intake structures, discharge facilities and chute and energy dissipation.

This work will establish the comparative costs of each arrangement and determine any reduced or increased rock fill volumes excavated from the different alternatives. The Consultant shall determine the overall impact of these reduced or increased volumes on the cost of the dam.

Arrangements shall be prepared to show design features, to take off quantities and to develop cost estimates to an appropriate level to make a selection of the best alternative. The most promising arrangements shall be discussed with the Client, as and when appropriate.

Sub-task 9-5: River Diversion and Management

The Consultant shall review and optimise the River Diversion and Management design as proposed during the Feasibility Study. The review shall include consideration of risks associated with diversion floods during dam and appurtenant structure construction. Alternative arrangements shall be carefully examined to determine the optimal scheme in terms of cost, risk, hydraulic performance and constructability. Preliminary drawings of all alternative arrangements shall be prepared in sufficient detail to show design features, to take off quantities and to develop comparative cost estimates at appropriate levels to make a selection of the best alternative. The most promising arrangements shall be discussed with the Client.

Sub-task 9-6: Outlet Works

The Consultant shall review the outlet work facilities as recommended in the Feasibility Study. The Consultant shall then develop and optimise the outlet work facilities based on the preliminary designs of the dam and the river diversion and management requirements, and the dam construction programme. The Consultant shall ensure that the design of the outlet works complies with applicable dam safety requirements, environmental flow requirements and operations and maintenance requirements. Preliminary drawings of all alternative arrangements shall be prepared in sufficient detail to show design features, to take off quantities and to develop comparative cost estimates at appropriate levels to make selection of the best alternative. The most promising arrangements shall be discussed with the Client.

Sub-task 9-7: Hydro Power Station

The Consultant shall undertake the feasibility study and design of the hydro power station and associated diversion works. The sizing of the hydro power station shall be optimized on the basis of the environmental flow releases and reservoir operating rules. The pattern of the releases shall be discussed and agreed with the Client prior to undertaking any studies. The services shall provide for a plant of one or two units each with all the necessary mechanical and electrical equipment.

Sub-task 9-8: Works Areas and Camps, Location and Requirements

The Consultant shall review the requirements for his own site facilities and for the contractor's works areas, quarries, labour camps and other facilities, with estimates of power, water supply, solid waste management and waste water treatment demands. This information shall be provided to the Project Housing and Associated Infrastructure consultant and the Bulk Power and Telecommunications consultant for their planning purposes.

Sub-task 9-9: HAZOP Study

The Consultant shall carry out a hazard and operability study (HAZOP study) on the Preliminary Design.

Sub-task 9-10: Constructability Review

The Consultant shall carry out a constructability review of the Preliminary Design. The Consultant shall evaluate and prepare construction requirements with emphasis on constructability, construction sequencing and material handling aspects. Any climatic influences, external and internal influences affecting construction activities and scheduling such as quarry operations, construction equipment and

processes, work force skills and productivity shall be addressed. The Consultant shall give special consideration to the procedures as they pertain to hazards that affect the work site during construction.

Sub-task 9-11 - Cost estimate

Construction cost estimates for the proposed dam type will be prepared. The Consultant needs to indicate the information used, the accuracy of the estimates and possible impacts on final costs due to uncertainties in available information. Sufficient attention needs to be paid to project-related infrastructure such as temporary works, permanent access roads, power supplies, site buildings etc.

Sub-task 9-12 - Preliminary Design Report, Cost Estimate and Construction Programme

The Consultant shall prepare a Preliminary Design Report with drawings summarizing the findings of his investigations and studies for all the works under this scope and presenting and motivating the final arrangement of the scheme, including the detailed design criteria to be adopted during the Tender and Construction Designs.

The Consultant shall prepare a Cost Report based on the Preliminary Design.

The Consultant shall prepare a Preliminary Construction Programme for the construction work and pre-construction engineering activities (design, tendering, mobilisation and activities by others), using critical path methods, relating this Programme to the expected construction methods and showing:

i. duration of all major activities
ii. milestone dates for major events
iii. the critical path

The Consultant shall prepare a preliminary designer's health and safety report including a 'baseline risk assessment', in accordance with the requirements of the relevant authority.

Deliverable: Comprehensive Feasibility study for the GEBA multipurpose dam

Workshop 3: Presentation of the preliminary design study for the GEBA multipurpose dam to be taken to design[4]

PHASE 2: DESIGN STUDY AND PREPARATION OF TENDER DOCUMENTS

Under this task, the Consultant will prepare tender designs and documentation in line with international standard guidelines and incorporating both Health and Safety and Environmental aspects.

Task 1 - Updated EMP and Compilation of Environmental Specifications

The Environmental and Social Impact Assessment (ESIA), including a draft Environmental Management Plan (EMP) will be prepared by others. This work will be carried out partly in parallel with the engineering design services. The Consultant shall therefore liaise closely with the ESIA consultant during the design period, and incorporate the EMP into the Tender documents as it is made available. The Environmental Manager shall critically review the environmental mitigation and monitoring measures contained in the EMP and revise such measures as deemed necessary. The Environmental activities shall be undertaken in accordance with relevant legislation and policies, supplemented where appropriate with reference to internationally recognised standards.

The Consultant shall prepare environmental specifications, using the draft EMP, and subsequently the approved EMP, for inclusion in tender documents, to ensure that all potential negative impacts are mitigated. The specifications shall include contractual penalties for any environmental damage caused

[4]Additional workshops that may be required should be proposed by the Consultant in his methodology. Workshops for presentation of Geba and TAMS feasibility studies can be organised together or separately.

on site, or non-compliance with the Environmental Specifications. The consultant shall identify those aspects of the works (not identified during the ESIA process) which have potential negative environmental impacts, and include appropriate measures to mitigate these effects in the revised EMP.

Task 2 - Compilation of Environmental Baseline (Natural and Social)

The Consultant shall undertake the following tasks:

i. Define the scope and detailed specification for the establishment of an Environmental Baseline against which the contractor shall be required to monitor. This baseline will form the basis for the environmental control parameters in the Specification. Typical variables for which an environmental baseline is required include water quality, ambient dust, ambient noise, traffic volumes and waste (where applicable).

ii. Establish an independent environmental baseline before commencement of construction. Monitoring of environmental parameters potentially affected by construction shall be carried out over a sufficient time period to identify the annual variation in each parameter where practicable. Monitoring shall be sufficient to establish a baseline for all areas (streams, communities, other affected locations) directly impacted by the Project.

iii. Develop a record of all activities, land uses and structures situated within approximately 50 metres of the site boundary(ies). The purpose of the record is to identify specific land uses and structures adjacent to the site boundaries where special arrangements may need to be agreed with land owner(s) to ensure good project relations. Where activities such as blasting may affect neighbouring property owners over a wider area, the area recorded shall be extended appropriately.

iv. The Consultant shall prepare a record of all assets and or infrastructure potentially affected by the Project, for the future assessment of construction impacts on assets not covered by the Resettlement Action Plan. This will include a photographic record and GPS co-ordinates of each asset. The Resettlement Consultant(s) will prepare a detailed record of all assets involved in the resettlement process (those permanently lost due to the Project). They will not address other assets (properties, infrastructure and so on) which may be affected during construction but not be due for expropriation.

v. The Consultant shall prepare an Environmental Baseline Report, recording the results of sub-tasks i) to iv) above.

Task 3 - Support Services to the Client

The Consultant shall undertake the following tasks:

i. Identify all permanently and temporarily impacted land portions, compile a Schedule of Impacted Land Portions, and compile maps and drawings per affected cadastral portion. The Consultant should specify when access to the land portions is required for construction purposes. This information is to be provided within 3 months of commencement of the Contract.

ii. Compile an access protocol on how to interact with impacted land owners. The Protocol will be submitted to the Client for approval.

iii. Provide ongoing support to the Client for land acquisition. The Consultant shall inform the Client of instances where detailed design resulted in significant changes to the access requirements of permanent and temporary land portions. Note that the actual process of land acquisition and resettlement will be managed by the Client through the Resettlement Consultant(s) under other contracts.

Task 4 - Tender Design

To provide the Services for this stage the Consultant shall assemble team(s) of engineers and other specialists, experienced in the conceptual, tender, detailed design and documentation of large dams and appurtenant works. In addition, the team(s) shall be experienced in geological and geotechnical investigation, testing and analysis, hydraulic design, dam design, structural design, civil works design,

electrical and mechanical design, cost estimating and programming, construction methodology development and environmental monitoring. The Consultant shall provide the Services, carry out such duties and assume such powers and responsibilities as are defined in this Contract, and as are necessary for the due performance of the Services.

Based upon the approved Preliminary Design and utilizing the survey data and any further geotechnical data, the Consultant shall prepare tender designs. The Consultant shall undertake his structural designs in compliance with state of the art practice and internationally recognized and applicable local codes and standards. The designs shall conform to and be suitable for the site conditions, and shall use locally available materials and labour to the greatest extent possible. They shall aim to achieve minimum overall cost without adversely affecting the environment, the health of the workers, or the safety, security, efficiency or longevity of the Works. Convenience of operation including remote control shall be considered. The permanent works equipment shall be designed to be readily maintained with locally available spares wherever practicable.

The Tender Design and preparation of tender documents shall be to a level that will allow construction design to proceed without the need for further field investigations and without major changes to the tender design. Should unexpected subsurface conditions arise, the study activities shall be reviewed and an approach to deal with the conditions shall be proposed by the Consultant. Such approach shall be subject to the approval of the Client.

The Tender Design process shall include the following sub-tasks:

Sub-task 4-1: Design Basis Memorandum

The Consultant shall formulate a Design Basis Memorandum (DBM) setting out in detail the criteria, assumptions and parameters to be used in the Tender Design, ensuring compliance with state of the art practice and internationally recognized and applicable local codes and standards. This work shall include such items as loading cases, factors of safety, allowable stresses, seismic design criteria, stability criteria, allowable loading, acceptable and appropriate standard details, minimum materials and operational requirements, instrumentation monitoring requirements and all other factors necessary for the Tender Design. The memorandum shall include methodologies for the application of the criteria in the Tender Design and will define the design approach, the analysis steps and development and the various computer software programs to be applied for the analyses and for all Tender Design work. The DBM shall be submitted to the Client for comment and acceptance.

The Consultant shall advise the Client on any special surveys, data collection activities, sampling, laboratory tests and analyses, or other tests that may be needed for completion of the tender design. After agreement of the Client to the need for such work, the Consultants shall draw up specifications and assist the Client with procuring the necessary services.

Sub-task 4-2: GEBA Dam and Appurtenant Works Design

The Consultant shall design the Works taking into consideration information from the above tasks and any additional information from any other source. The design shall be carried out to a level of detail sufficient for international tendering and will address the dam, ancillary works, water treatment plants, bulk pipelines, canals etc.. For all significant structures and elements, this work shall include, but not be limited to, the complete design of hydraulic structures, foundation treatment and grouting, instrumentation, seepage analysis, stability, deformation and stress analysis and architectural work and finishing.

The analysis and design of the dam must demonstrate to the Client that cracking, excessive settlement in any direction and unexpected seepage/leakage will not occur at any stage during the dam construction, impoundment and operation.

All Tender Design investigations, reports and drawings must be prepared to an adequate level to allow Tenderers to easily understand the requirements of the proposed works, to understand the proposed construction and accordingly, to accurately resource, programme and price all scheduled items of work.

In the case of reinforced concrete, sufficient structural calculations shall be made to justify the concrete dimensions and the quantities of reinforcement. The arrangement of bars shall be considered in sufficient detail to ensure that their placement is technically feasible and economic and that indicative reinforcement drawings can be developed, showing the nature of the construction work involved. Detailed reinforcement drawings and bar lists will not be required to be prepared by the Consultant for the Tender Documents.

The designs shall conform to and be suitable for the site conditions and shall use locally available materials and labour to the greatest extent possible. They shall aim to achieve minimum overall cost without adversely affecting the environment, the health of the workers, or the safety, security, efficiency or longevity of the Works. Convenience of operation including remote control of equipment shall be considered.

The Tender Design and preparation of Tender Documents for civil and electromechanical

Works will be based as far as possible on standardized manufacturer's equipment and shall consist of justification of the choice of the equipment, operating conditions and the main design criteria. Information regarding the design of the Small Hydro shall be included in the Tender Design Report.

The Consultant shall provide complete designs for the mechanical and electrical systems, drainage, lightning, etc. for the above items and shall specify the components required for these systems.

For the major items of mechanical and electrical equipment such as gates, valves, bulkheads, etc., the Consultant shall define the outline design and specify performance characteristics of the equipment in sufficient detail for the equipment suppliers to undertake detailed design and manufacture.

The Consultant shall prepare all necessary documents as required by internationally recognized standards on the safety of dams which include:

i. A construction supervision and quality assurance plan
ii. An instrumentation plan
iii. An operation and maintenance plan
iv. An emergency preparedness plan

In addition, the Consultant shall also carry out dam break studies to establish the potential inundation area downstream of the dam. Inundation mapping, at an appropriate scale, shall be prepared to define the area of risk.

The Consultant’s Tender Design shall include all components of the permanent works and all work within the design scope and the scope and cost shall not be reduced by passing inappropriate design responsibility to the contractor.

Sub-task 4-3: Construction Infrastructure – Access Roads, Quarries, Works Areas, Layout and other requirements

The Consultant shall prepare preliminary layout designs of site access roads, quarries, construction yards and works areas sufficient for tender purposes. All local construction access roads and services will be within the dam contractor’s scope.

The Consultant shall identify site establishment requirements and the need for any additional road(s) outside the Permanent Access Roads. Site roads shall include possible contractor’s roads to quarries, spoil areas or other work locations. The consultant shall liaise with Urban planners/Architects in the selection of appropriate works areas. Detailed design of temporary construction infrastructure shall be the responsibility of the relevant contractor.

The Consultant shall estimate the power requirements of the contractor and advise the Client. The Consultant shall describe the construction power system in the Tender Documents so that the

contractors can cost and design any electrical connections and protection arrangements required for the construction.

The Consultant shall address the water supply and treatment for potable use at the construction site in the Tender Documents.

Sub-task 4-4: Trial Blasting and Trial Embankments

The Consultant shall plan a programme of trial blasting of test quarries and construction of trial embankments to be carried out at an early date during the construction contract to enable optimization of the construction design. The programme and detailed requirements shall be included in the Tender Documents.

The Consultant's test programme shall include, but not limited to the following elements:

i. trial blasting of quarries,

ii. trial embankments which investigate the effects of layer thickness, compaction effort, rock fill gradations and sluicing for rock fills,

iii. comparison of field compaction trials to laboratory compaction testing of modelled rock fills.

The Consultant shall also take note of durability testing carried out during the feasibility study.

Sub-task 4-5: Concrete Mix Designs

The Consultant shall undertake the design of concrete mixes for each of the grades of concrete to be utilised in the structural designs. The Consultant shall undertake statistically valid testing to prove his designs.

Sub-task 4-6: Designer's Health and Safety Report and Specifications

The Consultant shall update the 'baseline risk assessment', produce site specific health and safety specifications and produce the designer's Health and Safety Report in accordance with the requirements of the relevant authorities, policies and legislation. In particular a coherent system of formal appointments, responsibilities and accountabilities shall be specified to ensure that those who are actively in authority over the workforce are accountable for the workers' safety. Where appropriate the Consultant's project staff shall be included in the appointments structure.

The Occupational Health and Safety provisions shall be on the following basis:

i. The contractors will have primary responsibility for the occupational health of their own workforce, including annual health screening, first aid, general medical care, health education and emergency medical response. The contractors are to provide occupational health facilities on site. These resources will be made available to the Engineer's and Client's staff associated with that contract.

ii. The contractor will provide emergency response (ambulance, paramedic, medical stabilisation) for major incidents, including helicopter landing facilities at each major site for emergency evacuation.

iii. The contractor will provide an emergency response team, either through training and equipping their own staff, or by contract with a regional support team.

The Consultant shall liaise with the consultant for the Public Health Action Plan (PHAP) and the consultants for the other major engineering packages to identify the appropriate off-site facilities for major medical treatment (local clinics, district hospitals or regional hospitals).

The Consultant shall liaise with the consultants for the other major engineering packages to determine the practicality of standardizing core safety policies across the project (for example alcohol testing, traffic offences, 'zero tolerance' issues). An access control system shall be implemented by the

contractor to manage construction site and tunnel portal entry and exit. A database recording safety induction, driver status, medical, blacklisting etc. shall be maintained for all personnel on site.

Sub-task 4-7: Compilation of Tender Design Report

- **Technical Memoranda:** At pre-determined milestones throughout the Tender Design process, the Consultant shall submit technical memoranda on particular parts of the work. The Consultant shall identify such milestones in his Baseline Programme developed under Sub-Task C1. Each memorandum shall set out the concepts, methods, criteria and key parameters used in design, the results of design calculations, a clear discussion of the reasoning behind the technical decisions involved, indications of related matters still to be settled, and a brief account of the implications for costs and programming. These reports shall be submitted as soon as possible after work performed for specific items.
- **Tender Design Report:** The Consultant shall submit a self-contained report describing the tender design, consolidating the information covered in previous submissions, with any revisions made in the course of discussion, review and refinement.

The contents of the Tender Design Report shall include but not necessarily be limited to the following:

i. methods used in design;
ii. reasons for technical decisions;
iii. indicative construction programme;
iv. details of further design work required during construction, with recommended methods and criteria;
v. reference to all technical memoranda and other design reports;
vi. design sketches and drawings and calculations in appendices; and
vii. link with cost estimate.

The report shall be prepared and issued initially as a draft report for review by the Client. It shall include the results of all studies and investigations, with tables and drawings and it shall, after review and incorporation of all queries and acceptance by the Client, be re-issued in final form.

Sub-task 4-8: Prepare Tender Documents, Engineer's Programme and Cost Estimate

The Consultant shall produce Tender Documents for a contract for the construction, supply and installation of equipment and commissioning of the Works, including maintenance of Project access roads, which shall be in accordance with the FIDIC Tendering Procedure Guidelines and the Client's Contractor Procurement Strategy. The Consultant shall discuss in detail with the Client the extent to which tenderers should be permitted to suggest alternative designs, construction methods, or temporary works.

The Consultant shall review the scope of work provided under this contract and:

i. identify the interfaces required with others
ii. identify additional items to be provided by others for the proper execution of the contract
iii. assist the Client in identifying construction-in-progress assets for inclusion in a master asset registry

The Consultant shall also consider the physical, programme and contractual interface between the main works and other contracts to minimise the potential for disruption, delays or claims by either contractor.

The documents shall describe the Works, including temporary works as necessary, in sufficient detail to allow tenderers to confidently determine their cost of construction, and ensure the receipt of comparable tenders.

The Tender Documents shall include and will not be limited to the following:

i. Drawings, sufficient for tender purposes

ii. Bill of Quantities (BoQ), in accordance with a recognised standard method of measurement of civil engineering works, which shall include sufficient items to enable the evaluation of design modifications and other variations

iii. Technical Specifications, including requirements for environmental protection and health and safety

iv. Conditions of Contract, using the FIDIC 'Conditions of Contract for Construction for Building And Engineering Works Designed By The Employer, Multilateral Development Bank Harmonised Edition, June 2010' (FIDIC). These shall include requirements for the management of construction programmes based on the Delay and Disruption Protocol issued by the Society of Construction Law (www.scl.org.uk) and local procurement preference.

v. Factual information, including Geological, Geotechnical and Materials Report

vi. All associated documentation for the complete Tender process

vii. Engineer's Programme. This shall include the construction work and pre-construction engineering activities (design, tendering, mobilisation and activities by others) using critical path methods, relating this Programme to the expected construction methods, and showing at least:
   - duration of all major activities;
   - logic linkages (e.g. Finish to Start);
   - work breakdown structure;
   - resources allocated against all major activities;
   - interfaces with other contracts (deliverables and receivables);
   - milestone dates for major events;
   - the three most critical paths and extent of criticality involved; and
   - proposed measures to mitigate potential delays.

The Consultant shall demonstrate that the indicative programme fits into the overall construction programme and satisfies the Client's requirements. The programme shall be formulated in sufficient detail to facilitate preparation of realistic cost estimates.

The Consultant shall produce the Engineer's Estimate of construction costs, which shall include the projected cost together with the Consultant's indication of areas of uncertainty (risk). The Engineer's cost estimate shall include a resource based cost estimate, using the Engineer's Programme, and comparison with a Bill of Quantities based estimate. The cost estimate must be suitable for presenting to international financing agencies and/or organisations such as commercial banks and export credit groups. The format is to be discussed with the Client. Cash flows shall be prepared from the cost estimates and shall include the effect of contract price escalation. The cash flow shall also take into account the effect of any advance payments, interim valuations, retention, etc.

Under this task the Consultant shall print and bind the documents and shall provide the Client with a number of copies as specified.

Deliverable: Design studies and tender documents for the Geba multipurpose dam

Workshop 4: Presentation of the design study for the Geba multipurpose dam for validation and finalisation[5]

[5]**Workshops for presentation of Geba and TAMS design studies and tender documents can be organised together or separately.**

3.2.3 Component 2C: Baro River Irrigation Development

This component is focused on the development of irrigation using water from the Baro River. While the primary purpose of the component is concerned with irrigation development, it is important that the irrigation scheme is seen as a component of the overall system, providing i) multipurpose opportunities directly associated with the scheme (integrated aquaculture, livestock and dairy, agro-processing etc and ii) associated with the way in which it can modify the downstream flows the Baro and Sobat Rivers.

All preparatory work concerned with the collection of available studies and assessment of the current status of the project will have been completed as part of the overall programme Inception and Scoping Phase.

PHASE 1: FEASIBILITY STUDIES

A number of schemes have been identified in the IWRDMPlan. Tentative sequencing has been provided but this has to be investigated as part of the (comparative) feasibility study. Phase 1 of the programme is aimed at implementing the most feasible 60,000ha of irrigation from the Baro River.

Task 1: Comparative assessment of irrigation schemes and sequencing plan

The choice of schemes to be implemented should take into account:

- Baseline study of the bio-physical, socio-economic and institutional environment
- Needs and potential of the area and justification for the project
- Environmental and Social Impact Assessment (ESIA): assessment of the potential positive and negative impacts of the projects and proposition of i. avoidance/enhancement ii. reduction iii. Mitigation iv. Offset measures. These measures should be costed. .
- Economic (cost-benefit analysis) and financial analyses (both analysis should include a sensitivity analysis).
- Then other essential aspects such as resilience of the project to climate change, impact on conflict resolution and reduction of gender inequalities should be included.

Once the scheme(s) have been selected, the feasibility study at the level of this component should be focussed on the selected scheme(s) (60,000 ha is needed for implementation over 5 years (Years 6 – 10)

As part of the feasibility/preliminary design study, the consultant should carry out the following tasks.

Task 1: Assessment of water resources availability

Refer to Component 1

Task 2: Topographical Surveys

This task essentially aims to establish the command area. Based on the preliminary surveys carried out as part of component 1, the consultant will conduct any further topological and/or soil surveys to finalise the understanding of the characteristics of the area. The Consultant will be expected to prepare 1:10,000 scale topographic maps of the projects with 5 m contours to design the irrigation command area.

Task 3: Irrigable Command Areas Design

The objective of this task will be to prepare feasibility level designs for development of the irrigation command areas. Detailed activities under this task are the following:

- **Irrigation Potential Assessment including**: (i) evaluation of potential crops and cropping patterns; (ii) assessment of land suitability for irrigation; (iii) evaluation of irrigation water requirements; and (iv) assessment of water resources availability and options for developing water resources to meet the irrigation demand.
- **Command Areas Development**: prior to commencement of any design, design criteria should be approved by the Client. The scope for command areas development will include the following: (i) analysis of flood protection, land reclamation and drainage works required to ensure sustained economic operation of the command areas, (ii) determination of access road requirement both to and within the area, (iii) preparation of general layout plans showing the location and principal features of main works required for the most suitable irrigation supply and drainage system.
- **Irrigation System Engineering Design**: The consultant will prepare designs for major structural and hydraulic elements of the proposed irrigation system, including the water conveyance system, on-farm water distribution system, drainage canals system, flood prevention and control considering both structural and hydraulic safety. The consultant should take into consideration intensive labour engagement and use of local construction capability and materials during the design.

Deliverable: Feasibility study for the Baro river irrigated agriculture development (Month 36)

Workshop 5: Presentation of the study to be taken to design[6] (Month 36.5)

PHASE 3: DESIGN STUDY AND PREPARATION OF TENDER DOCUMENTS

Task 1: Confirmation of project layout, construction plans and implementation scheduling

Based on the preceding tasks and the comments received during workshop 3, the consultant will confirm the project layouts, and prepare the final desk project layouts. Then, the Consultant shall establish construction schedules for the project implementation. This should include mobilisation of the local communities, construction of access roads, mapping and information, work methods and preliminary labour force requirements. Finally, the project schedule should be detailed.

A capacity building programme should be designed.

Task 2: refinement of the ESIA

Based on the work done under Task 1, the ESIA shall be refined.

Task 3: refinement of the economic and financial analysis

The economic and financial analysis will be refined for the selected schemes

Task 4: Institutional arrangements

The objective of this task is to design institutional arrangements for the proposed project. This will cover (i) detailed assessment of the institutional (including environmental and social) capacity of local agencies relevant for implementing (or concerned by) the project. (ii) implementation and operation and maintenance arrangements for the project. The consultant will explore opportunities for various social groups (women and men), to participate in decision making processes.

Task 4: Monitoring and evaluation framework

For each project, the Consultant will prepare a monitoring and evaluation framework.

[6] **Additional workshops that may be required should be proposed by the Consultant in his methodology.**

Task 5: Tender documents

Under this task, the Consultant will prepare tender documents which should follow international standard guidelines.

Deliverable: Design studies and tender documents for the irrigation schemes (Month 48)

Workshop 6: Presentation of the design studyfor the irrigation schemes for validation and finalisation (Month 48.5)

PHASE III: CONSTRUCTION OF THE SCHEMES

Implementation of the schemes will be carried out under a separate contract.

3.2.4 Component 2D: Sobat River Irrigation Development

This component is focused on the development of irrigation using water from the Sobat River. While the primary purpose of the component is concerned with irrigation development, it is important that the irrigation scheme is seen as a component of the overall system, providing i) multipurpose opportunities directly associated with the scheme (integrated aquaculture, livestock and dairy, agro-processing etc and ii) associated with the way in which it can modify the downstream flows the Baro and Sobat Rivers.

All preparatory work concerned with the collection of available studies and assessment of the current status of the project will have been completed as part of the overall programme Inception and Scoping Phase.

The steps to be followed are the same as the detailed for the Baro irrigation component. 40,000ha are targeted for development during Phase 1.

3.3 COMPONENT 3: OTHER INFRASTRUCTURE COMPONENTS

3.3.1 Introduction

One of the principles of the proposed project is to use the developed water resources infrastructure to meet the development needs of several sectors. This should increase the economic feasibility of the project and at the same time maximise the use of water. In the case of this development, with upstream storage and hydropower, the resultant regulated flow will support the development of irrigation. The irrigation component is already covered under Component 2. However, the upstream storage can also be used to support (directly and indirectly) a wide range of other sectoral developments. One of the aims of Component 3 is to investigate the potential development opportunities for all water-related sectors and to detail the planning and design and operationalisation (including construction and implementation) where required. The economic sectors where the development of infrastructure may be required include:

- Navigation
- Power interconnection
- Fisheries and Aquaculture
- Livestock production
- Tourism and recreation
- Water supply and Sanitation

The Consultant will be required to carefully examine the current status of all these sectors during the baseline (see Component 1), and to look at bot needs and opportunities.

Deliverable: Feasibility studies for the other infrastructure components (Month 36). The Consultant shall propose workshops corresponding to significant milestones in his proposal.

3.3.2 Component 3A: Navigation

OVERVIEW

The objectives of this task are i) to investigate and evaluate the feasibility of investments to improve the role of navigation in the sub-basin within the context of regional transport and access to markets as a whole, ii) to carry out the necessary planning and design work to get the project ready for implementation. The study will look carefully at the transport needs that will be generated by accelerated development within the sub-basin, assuming that a major driver in this accelerated development will be the rapid expansion of commercial irrigation in both the Gambella Region of Ethiopia and on the Sobat River in South Sudan. The improved navigability of the BAS system, potentially allowing the movement of produce all the way from Gambella to both Juba and Khartoum, could play a significant role in the feasibility of proposed developments under the BAS IWRDMPlan.

PHASE 1: FEASIBILITY

The feasibility study will be based on a comprehensive assessment of the current status and opportunities. This assessment will carried out as part of the overall baseline study.

Activities would include the assessments of:

- Existing and potential demand under different development scenarios. It is important to look at a wide range of demand growth scenarios ranging from historic growth through tone in which a regional approach to food security could drive a growth in regional transport demand
- Connectivity with existing and potential overland transport. Any major growth in river transport would require a major improvement in connectivity with existing transport networks
- Possible approaches to maintaining a navigable river from Gambella to Sobat mouth. Assessment of vessel types/sizes
- Port infrastructure and intermodal transfer facilities requirements
- Institutional aspects/implications
- Costs and economic analysis of options
- Analysis of feasibility under different scenarios

PHASE 2: DESIGN STUDY

Based on the most feasible option, preparation of design for all aspects (regulation, dredging, port infrastructure, development of support infrastructure and services). This will cover what should be done by Year 5 and for Years 6 to 10.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

To be covered under a future terms of reference depending on the outcomes of Phases 1 and 2.

3.3.3 Component 3B: Hydropower Interconnection

OVERVIEW

It is important that the development of hydropower in the sub-basin brings transboundary benefits to those living within and around the basin. At present there is no interconnection providing electricity to South Sudan and virtually no national grid. The South Sudan portion of the sub-basin is also in the same condition, without access to an integrated power network. Only one per cent of the South Sudan population has access to power, though intermittently during a 24-hour period. Only seven per cent of the urban areas in South Sudan are electrified and virtually no rural areas have electricity.

While there is an advanced initiative to link South Sudan to Uganda, there is a need to develop more interconnection. A memorandum of understanding was already signed between South Sudan and Ethiopia to look into the option of an Ethiopia-South Sudan interconnection via Gambella.

PHASE 1: FEASIBILITY

An interconnection is planned between Ethiopia and South Sudan whose first phase goes directly through BAS territory. According to existing plans, this interconnection will consist of two separate routes:

- Phase I: 230 kV transmission line from Gambella in Ethiopia to Malakal in South Sudan. The distance from Gambella, South Sudan to the border in Ethiopia is around 105 kilometers and from border to Malakal is around 230 kilometers. The total distance of phase I is 335 kilometers. This is the continuation of the line recently constructed up to Gambella.
- Phase II: 500 kV transmission line from the proposed Dedesa substation in Ethiopia to Tepi and from Tepi to South Sudan border and to Juba. From Dedesa South Sudan to South Sudan Border is around 300 kilometers and from the South Sudan border to Juba is around 400 kilometers. The total distance of phase II is 700 kilometers.

It is expected that the project will interconnect Ethiopia and South Sudan, Juba and Malakal cities.

Based on the existing information and information to be collected during the baseline, the Consultant will carry out a detailed feasibility study on the proposed interconnection, suggesting any appropriate modifications to the existing preliminary design.

PHASE 2: DESIGN STUDY

If the project is found to be feasible, the required design work will fall under this contract. The details of the terms of reference will be developed at a later stage. Allowance for the design works should be estimated and provided as a provisional lump sum.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

To be covered under a future terms of reference depending on the outcomes of Phases 1 and 2.

3.3.4 Component 3C: Fisheries and aquaculture

OVERVIEW

During the BAS IWRDMPLan study, it was found that the main fish markets are the major towns in Gambella closer to water bodies (Gambella Town, Itang, Abobo and Pugnido). In these towns it appears that there is great demand for fish, far in excess of availability. Fish processing (value

addition) is rarely practised and in most cases, the fishers sell whole fish which brings low price at landing sites as well as secondary markets. Transport issues are a major constraint to the development of fisheries.

It appears that currently there is no aquaculture practised in the region, despite favourable conditions for development of the sector (abundant water and land, low altitude and high temperature, appropriate and proven indigenous fish species for aquaculture, inexpensive labour and compacted clay soil that can retain water for long). Aquaculture will produce more fish year round and also reduce the pressure that could otherwise be exerted on the natural system.

There is a huge potential and demand (locally and further afield) for fish. The development of capture fisheries and aquaculture must therefore be a key component of any multipurpose development.

PHASE 1: FEASIBILITY

The feasibility of developing fisheries (including aquaculture) should focus on the following main areas:

- Development of capture fisheries in the new reservoirs formed by Tams and Geba reservoirs.
- Development of rizipisci culture, the rearing of fish along with paddy as a sustainable system involving concurrent harvesting of paddy and fish as a unit reaping multiple benefits. This should take into account potential increased rice yields, other benefits and the additional costs involved.
- Development of aquaculture. This should look carefully at the development of both large-scale commercial aquaculture and artisanal aquaculture. The study should analyse and take into account the socio-economic drivers and requirements for aquaculture development.
- Development of existing capture fisheries in the natural environment, especially large wetlands. Fisheries are very underdeveloped. The feasibility study will take into consideration the existing constraints to development and what would have to be done to remove these constraints.

The feasibility study should take into account technical, institutional (including the need for capacity building and extension services), environmental and socio-economic aspects. This should also take into consideration the availability of (and need for) adequate transport links and access to markets.

The output of the feasibility study will provide the fully costed details of both the soft and infrastructure actions that are required. Feasibility will then be determined through a cost-benefit analysis taking into account economic externalities.

PHASE 2: DESIGN STUDY

For all the feasible components of the proposed developments, the required design work will fall under this contract. The details of the terms of reference will be developed at a later stage. Allowance for the design works should be estimated and provided as a provisional lump sum.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

To be covered under a future terms of reference depending on the outcomes of Phases 1 and 2.

3.3.5 Component 3D: Livestock production

OVERVIEW

Livestock play a multitude of socio-cultural and economic functions in all three production systems (pastoral, agro-pastoral and mixed farming systems) observed in study area. They are the means for store wealth and providers of food and income. Milk is the most important nutritious diet derived from livestock in both production systems.Although some level of variability exists amongst different

livelihood and ethnic groups, the application of improved livestock husbandry practices is very much limited throughout the basin. **Change is vital for improving the socio-economic benefit** of livestock to their owners, and the conservation of water and the sustainable management of livestock and the grazing resources. A key result of the proposed development project can be a huge increase in the productivity of the livestock sector, in terms of both meat and dairy productions

PHASE 1: FEASIBILITY

As a first step, as part of the baseline the Consultant should establish the current status of the livestock sector, especially in terms of livestock numbers, offtake rates, access to markets etc. The assessment should also include the dairy sub-sector. The baseline assessment will also confirm and update the understanding of the issues and constraints confronting development of the livestock sector. These have been examined as part of the BAS IWRDMPlan study but should be verified and further detailed through adequate field investigation.

The Consultant should assess the possible future situation through the analysis of a number of scenarios raging from a continuation of the status quo through to one in which there is major growth in the livestock production. As part of the analysis carried out under the BAS IWRDMPlan Study one prognosis was that the creation of the dams' reservoirs and the development of fodder crops would favour livestock productivity and associated urbanisation will encourage a change of practices from pastoralism towards agro-pastoralism. Currently the split between pastoralism and agropastoralism is 75% - 25% and the assumption was made that this could increase to 70%-30%. Another important externality to be taken into account is the potential impact of urbanisation and socio-economic improvement which could support an increase in demand for livestock products.

PHASE 2: DESIGN STUDY

For all the feasible components of the proposed developments, the required design work will fall under this contract. The details of the terms of reference will be developed at a later stage. Allowance for the design works should be estimated and provided as a provisional lump sum.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

To be covered under a future terms of reference depending on the outcomes of Phases 1 and 2

3.3.6 Component 3E: Tourism and other development sectors

OVERVIEW

Currently, tourism and ecotourism are largely underdeveloped in the BAS despite the huge potential offered by its rich natural resources, especially as supported by water resources. Since 2001, International visitor arrivals in Ethiopia have shown a strong upward trend. Ethiopia has become a quite important tourism destination in Africa, not far behind Kenya in terms of tourism and travel's direct and total contribution to GDP. However, the Ethiopian part of the basin does not benefit yet from any significant growth in tourism, mainly because of a lack effort to develop infrastructure at all levels that facilitate tourism together with a lack of coordinated management.

In South Sudan, tourism has emerged recently but is currently stagnant for security reasons. However, once peace returns to all parts of the sub-basin and the study area, there are natural assets which have huge potential in supporting the development of (eco-)tourism. These include:

- The variety of ecosystems of the BAS, its relatively pristine state,
- the magnitude of the mammal and bird migrations. Wildlife experts consider that the mammal migration of the BAS is equal to that of the Massai Mara – Serengeti (visited by between 300,000 and 400,000 tourists annually).

There is an very large potential for natural resources-based tourism.

PHASE 1: FEASIBILITY

As with the other sectors, The Consultant will first have to establish a clear understanding of the status of the tourism sector in the study area. This should include (but not be limited to):

- an assessment of the number of current visits to the different parts of the basin and what are the attractions that they visit.
- An assessment of the existing infrastructure including hotels, transport etc
- An assessment of the tourism potential of the basin through consideration of each of the potential tourist attractions, both individually and in the form of circuits. This should include a clear analysis of how the various proposed sectoral and infrastructure developments could support or hinder development.
- Issues and constraints. The Consultant should differentiate between issues and constraints that are related to the current security situation and those which are not. This is important so that the feasibility of tourism development under conditions of peace can be properly assessed.
- The feasibility of tourism-based development should be assessed for a range of scenarios. These may include one scenario where security issues are taken in into account, but should focus on scenarios under peaceful conditions.
- Scenarios should take into account the potential impacts of the proposed developments. These may be both positive and negative. They may also highlight the need for specific management provisions to ensure the conservation of certain key natural resources. .

PHASE 2: DESIGN STUDY

The focus of the design part of the study will be on the enabling environment to support the growth of tourism. This enabling environment will include policy and institutional aspects that support the development of the key infrastructure and the protection of natural resources. The ail will be that given the appropriate enabling environment, growth in the tourism sector will be largely driven by the private sector.

Detailed terms of reference will be developed once the feasibility study has been completed.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

Development of the tourism sector will require both soft and infrastructure measures. The majority of the infrastructure measures may be largely unrelated to the water sector and beyond the scope of this project. However, it is important that the study highlights the requirements (transport, communications, services such as electricity etc.)

3.3.7 Component 3F: Water supply and sanitation

OVERVIEW

Access to sanitation in South Sudan, at 14.6% coverage is one of the lowest worldwide. In rural areas average consumption of water is 6 l/capita/day with only 20% of the population contributing to operation and maintenance costs and between 20% and 50% of water points were not operational. Adequate urban water supply systems are largely absent outside parts of Juba. The situation in Ethiopia is much better but there are rural areas and some urban centres which are badly served.

PHASE 1: FEASIBILITY

The work carried out in the baseline study of the BAS IWRDMPlan study will be updated and further detailed by the Consultant as part of the baseline for this study. This will require a combination of detailed desktop study, meetings with the key stakeholders in each country and some visits to the field. The aim will be to clearly establish the status quo for all the administrative areas within the study area. The areas of greatest need will be highlighted so that the provision of water and sanitation for these areas can be prioritised.

Having identified the areas of need, the Consultant will develop a number of development scenarios, paying particular attention to the water resources that may be made available through the development of other components of the project. These include the construction of dams and reservoirs, the availability of a more regulated flow, the construction of intakes for irrigation schemes etc. The details of the infrastructure components (for water supply and sanitation) of each development scenarios should be evaluated to the preliminary design level so that they can be adequately costed.

The costs and associated benefits, taking into account potential economic externalities will be taken into account.

PHASE 2: DESIGN STUDY

The design details for all the components of the selected water and sanitation components will be drawn up such that the required procurement documents can be prepared. The design phase will be the subject of a new terms of reference to be compiled once the results of the feasibility study are known.

PHASE 3: CONSTRUCTION AND IMPLEMENTATION

To be covered under a future terms of reference depending on the outcomes of Phases 1 and 2.

3.4 COMPONENT 4: CROSS-CUTTING AND ENABLING COMPONENTS

3.4.1 Component 4A: Watershed Management

OVERVIEW

Parts of the catchment are degraded and this has an impact on both the quality and quantity of flows in the rivers system and groundwater recharge; it is important that degradation, which is largely anthropogenic, is brought to halt and reversed. Degradation results in both reduced base flows and increased flooding, exacerbated by climate change. This has an influence on the design of infrastructure with major cost implications, easily in excess of the costs associated with livelihood-based watershed management programmes

PHASE 1: FEASIBILITY

The feasibility study is necessary in order to clearly demonstrate the absolute necessity for the design and implementation of watershed management programmes in all the critical areas of the study area. While such programmes should be sustainable in the medium and long-term, they may require seed funding and some infrastructure. The feasibility study should consider how infrastructure developed for economic sectors can pay for these costs, which can be seen as environmental services.

The first step of the study will be to ascertain the status quo in terms of catchment condition and to highlight the hotspots, especially this which may have a direct impact on the economic viability of proposed infrastructure.

The next step will be a plan for the entire study area, highlighting the areas for priority project implementation and drawing up a plan for the remainder of the project period. This plan should then be costed and used in the cost-benefit analysis.

PHASE 2: DESIGN STUDY

Design will be based on well-tested principles. The terms of reference will be drawn up once the detailed plan has been drawn up.

3.4.2 Component 4B: Transport and communication and Component 4C: Other services sectors (health, education, etc.)

As indicated in Table 2-1, the feasibility for the development of these sectors will be largely carried out by the responsible sectors and is outside the scope of this study. The outputs of this study will be limited to defining the requirements in these development support sectors.

4. METHODOLOGY, STANDARD AND DESIGN CRITERIA

The Consultant will be expected to employ the most effective methodology and standards to achieve results with optimal national stakeholder involvement. In addition, the Consultant will be expected to: (i) collect most data from review and analysis of existing secondary sources of information such as assessment reports and various other regional and relevant global publications; (ii) prepare clear, concise and focused reports; and (iii) ensure reports are delivered in time as per the agreement. International standards shall be used for the feasibility studies, and their application shall be appropriately referenced.

5. LIST OF REPORTS, SCHEDULE OF DELIVERIES AND PERIOD OF PEFORMANCE

The Consultant will produce the reports and attend the related meetings as given in Table 5-1[7]. The anticipated date (from the beginning of the project) for delivery of the reports and workshops is given.

Additional meetings/workshops with the Client and Ministries are strongly recommended to ensure the smooth progress of the study and should be proposed by the Consultant in his methodology.

[7] **In the table, the letter "C" refers to "Component". For instance "C-1" is "Component 1", etc.**

Table 5-1: List of deliverables and meetings

Deliverable and Workshops/Meetings		**Month (from the beginning of the project)**
Component 1: Overall multipurpose water resources development programme		
C-1A	Inception/kick-off meeting with the Client	Month 0.5
	Draft Inception and Scoping report	Month 3
	Inception workshop	Workshop 1 – Month 4
	Final Inception and scoping report	Month 5
	Overall development programme baseline report	Month 16
C-1A to C-1D	Presentation of the baseline Report	Workshop 2 - Month 16.5
	Overall Programme Feasibility Study Report	Month 60
Component 2: Core infrastructure components		
C-2A	Comprehensive feasibility study for the TAMS multipurpose dam	Month 12
	Presentation of the feasibility study for the TAMS multipurpose dam to be taken to design	Workshop 3: Month 12.5
	Design studies and tender documents for the TAMS multipurpose dam	Month 24
	Presentation of the design study for the TAMS multipurpose dam for validation and finalisation	Workshop 4: Month 24.5
C-2B	Comprehensive feasibility study for the Geba multipurpose dam	Month 12
	Presentation of the feasibility study for the Geba multipurpose dam to be taken to design	Workshop 3: Month 12.5
	Design studies and tender documents for the Geba multipurpose dam	Month 24
	Presentation of the design study for the Geba multipurpose dam for validation and finalisation	Workshop 4: Month 24.5
C-2C to C-2D	Feasibility studies for the Baro and Sobat river irrigated agriculture development	Month 36
	Presentation of the studies to be taken to design	Workshop 5: Month 36.5
	Design studies and tender documents for the irrigation schemes	Month 48
	Presentation of the design studies for validation and finalisation	Workshop 6: Month 48.5
Component 3: Other infrastructure components		
C3	Feasibility studies for “other infrastructure components”	Month 36
Component 4: Cross-cutting and enabling components		
C4	Feasibility study for the Watershed management component	Month 18

6. DATA AND SERVICES TO BE PROVIDED BY THE CLIENT

Data and documentation relevant for the project should be made available to the Consultant. However, the Consultant has the ultimate responsibility for collecting all the required data and documentation which cannot be made available by the Client.

The Client will:

- Facilitate communication with the relevant institutions,
- Liaise and assist the Consultant in obtaining any other information and documents required from government agencies
- Provide assistance for visas applications and work permit (if required) for staff of the Consultant
- Provide assistance in obtaining Customs and Tax Exemptions as detailed in Special Conditions of the Consultancy Agreement and General Conditions of Service,
- Arrange consultative meetings and ensure linkage with relevant regional authorities,
- Provide any document listed in the annex on request that the consultant may require either for purposes of preparing bid documents or in the course of the feasibility studies. The Consultant shall operate their own project office and shall bear all accommodation, local transportation, visas, and other costs necessary to carry out the assignment.

7. QUALIFICATIONS OF THE CONSULTANT

The study team should comprise experienced professionals, and include national/regional/international consultants as necessary to ensure study relevance and effectiveness in light of prevailing local conditions. The team should reflect an appropriate mix of disciplines, education, skills and experience, an understanding of underlying development issues, and regional experience. The specialists should have postgraduate qualifications and at least 10 years of experience in undertaking studies related to irrigation, hydropower and water resources development and watershed management. The areas of expertise required include: irrigation engineering and agriculture development, civil/infrastructure/hydraulic engineering, hydropower development, watershed management, rural development, hydrology, financial and economic analysis, geotechnical engineering, institutional analysis and environmental and social impact assessment. It may be necessary to include non-key experts covering agronomy, institutional aspects, livestock production and other areas. The Consultant may optimize their personnel to demonstrate the competences required for the assignment. The qualifications of the key experts are summarised as follows:

Table 7-1: Qualifications of the key Experts

Position	**Skills**
IWRM Expert (Team Leader)	The Team Leader will be responsible for the overall planning and implementation as well as coordination and management of the consulting team. He/she should be a graduate in in water resources or a related field with proven experience in integrated water resources planning. She/he shall have a minimum of fifteen (15) years overall experience and five (5)years relevant experience in preparing integrated water resources management and, development plans, implementation strategies and action plans. As Team Leader, he/she should demonstrate leadership skills and experience in managing a dynamic and multidisciplinary team of international and local experts. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.

Position	Skills
Watershed management Expert	He/she should be a graduate in natural resources management or a related field with at least 10 years relevant experience in land use planning, soil conservation, and rural development. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Dam Design/ Civil Engineer (TL)	He/She should be a graduate in Civil/Hydraulic Engineering, with at least 10 years' experience in water resources planning and design and construction supervision of hydraulic structures including dams and hydropower projects and associated ancillary structures. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Hydrologist/Modeller	He/She should be a graduate in hydrology/water resources engineering with at least 10 years of overall experience in the field of competence and five (5) years relevant experience in modelling hydrologic systems. She/he should have experience of the regional hydrological conditions. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Soil Specialist/Pedologist	He/She should be a graduate in soil sciences with at least 10 years' experience in soil investigation for irrigation and watershed projects. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Hydrogeologist	He/She should be graduate in hydrogeology sciences with at least 10 years of overall experience in the field of competence. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Environmentalist	He/She should be graduate in Environmental Engineering with at least 10 years of overall experience and five (5) years relevant experience in environmental assessments. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Sociologist	He/She should be graduate in Sociology or related field with at least 10 years of overall experience and 5 years relevant experience in social and livelihood assessments. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Economist	He/She should be a graduate in economics with a minimum of10 years of overall experience and 5 years relevant experience in economic assessment of water resources in different sectors and in financing patterns. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Water Supply Engineer	He/She should be a graduate in water engineering with a minimum of10 years of overall experience and 5years relevant experience in water supply-planning. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Irrigation Engineer	He/She should be a graduate in water engineering with a minimum of 10 years of overall experience and 5 years' relevant experience in planning and development of irrigation systems infrastructure, Agricultural Sector Development Programme, Agricultural Sector Development Strategy, and National Irrigation Master Plan. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
Hydropower Expert	He/She should be a graduate in Hydropower engineering with a minimum of 10 years of overall experience and 5 years relevant experience in planning and development of hydropower systems, National Power Master Plan, and interconnection. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.

Position	Skills
Fisheries Expert	He/She should be a graduate in Fisheries sciences with a minimum of 10 years of overall experience and 5 years relevant experience in inland fisheries and aquaculture. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.
GIS - Remote Sensing Expert	He/She should a graduate in GTS - Remote Sensing with a minimum of 10 years of overall experience and 5 years relevant experience in preparation of GIS based databases and maps. Recognition for additional relevant experience and/or relevant post-graduate qualifications may be given.

8. COST AND CONTRACT DETAILS

It is estimated that the work will commence in January 2018 and take 10 years. The initial contract will cover five years. During the course of this period, there will be new sub-contacts added to the main contract as addendums. Many of these will relate to downstream work such as design, construction and implementation for projects for which feasibilities have been completed under this study. Whilst all the Consultant's costs incurred in their participation, supporting the arrangement and running of report review workshops must be included in the Consultant's financial proposal, the costs of holding the workshops themselves (costs of venue, participants' expenses such as transport and accommodation, materials, etc.) will be met by the Client and should not be included in the Consultant's financial proposals. The costs of all other consultations, etc. required to complete the assignment must be included in the financial proposals.

9. SUPERVISION ARRANGEMENTS

The Client is the Nile Basin Initiative / Eastern Nile Technical Regional Office (NBI/ENTRO). The Consultant will be directly supervised and report to the Project Coordinator responsible for this study within ENTRO on behalf of the ENTRO Executive Director. At the national levels, the Consultant shall closely work with the Project National Project Coordinators with support of the Regional Project Steering Committee (RPSC) and Eastern Nile Technical Advisory Committee (ENTAC) members of both countries. Results from the study will be regularly communicated to the funding agencies through ENTRO. ENTRO will ensure close coordination with other regional projects, to ensure effective information exchange. The Client will hold discussions with the Consultant at various stages of the consultancy to assess work progress, discuss constraints and possible interventions to ensure quality and meet deadlines.

10. QUALITY ASSURANCE AND CONTROL

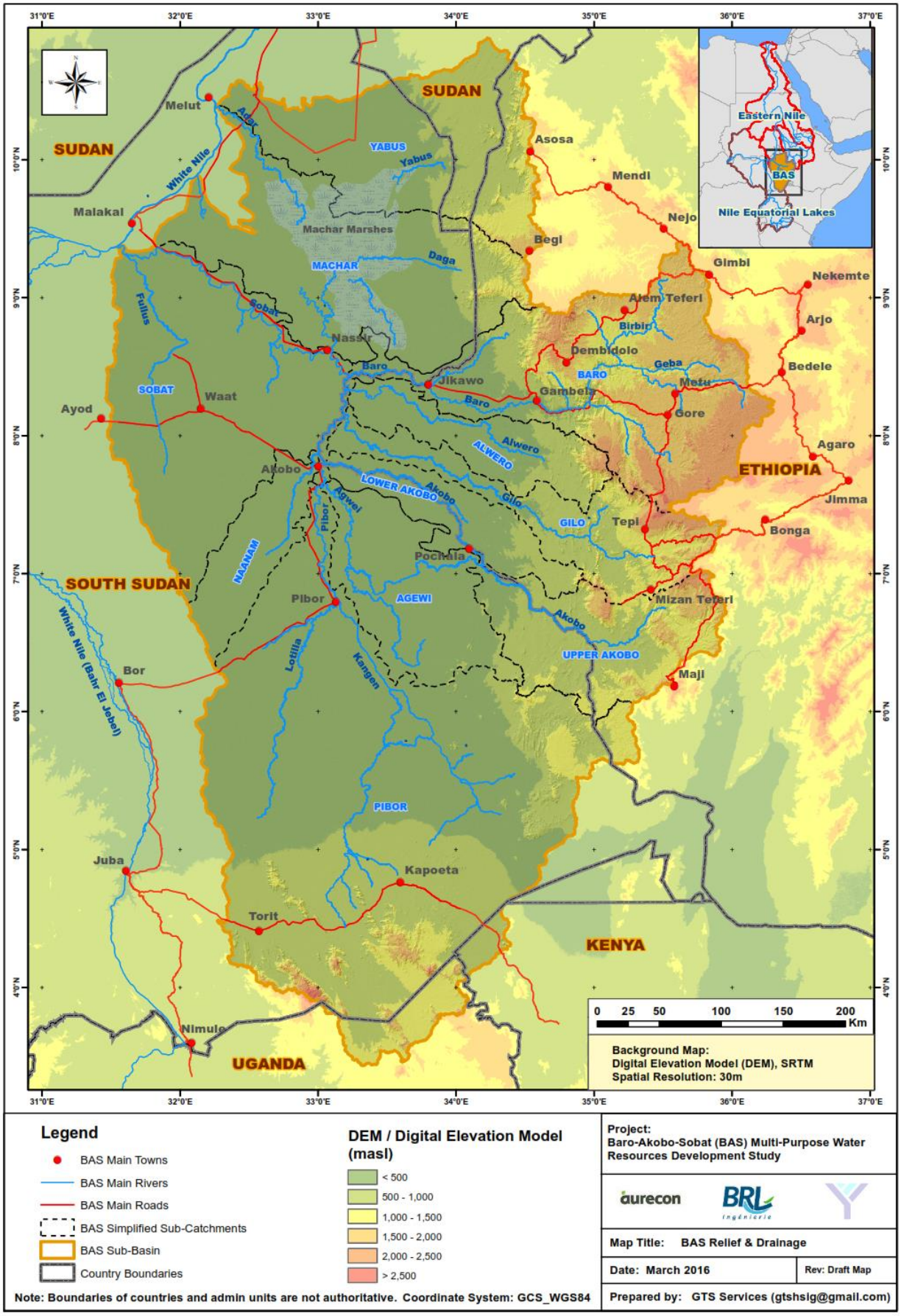
The Consultant will be required to demonstrate in their proposal evidence of adoption of the use of a Quality Assurance System (ISO 9001 or equivalent), as well as describe how quality control will be implemented during the assignment.

ANNEXES

Annex 1: Location of the BAS sub-basin within the Eastern Nile system


Mediterranean Sea
Israel
Palestine
Iraq
Jordan
Cairo
Nile
Saudi Arabia
Libya
Egypt
Lake Nasser
Nile Basin
Red Sea
Chad
Khartoum
Atbara
Eritrea
Sudan
White Nile
Lake Tana
Blue Nile
Bahr El Arab
Malakal
Sobat
Addis-Abeba
Baro
Gambela
Central
African
Republic
South
Sudan
White Nile
Akobo
Pibor
Ethiopia
Ghazal
Baro-Akobo-Sobat
sub-basin
Uganda
Lake
Albert
Lake
Kyoga
Kampala
Kenya
Democratic
Republic of
Congo
Lake
Edward
Rwanda
Lake
Victoria
Burundi
Indian
Ocean
0 100 200 300
km
Tanzania
N

Annex 2: Baro-Akobo-Sobat sub-basin, relief and drainage


SUDAN
SOUTH SUDAN
ETHIOPIA
KENYA
UGANDA
Melut
Malakal
Ayod
Waat
Nassir
Jikawo
Gambela
Akobo
Pibor
Pochalla
Bor
Juba
Torit
Kapoeta
Nimule
Asosa
Mendi
Nejo
Begi
Gimbi
Nekemte
Alem Teferi
Birbir
Arjo
Dembidolo
Geba
Bedele
Metu
Gore
Agaro
Jimma
Tepi
Bonga
Mizan Teferi
Maji
White Nile
White Nile (Bahr El Jebel)
Machar Marshes
YABUS
MACHAR
SOBAT
BARO
ALWERO
LOWER AKOBO
GILO
NAANAM
AGEWI
UPPER AKOBO
PIBOR
Eastern Nile
BAS
Nile Equatorial Lakes
0 25 50 100 150 200 Km
Background Map:
Digital Elevation Model (DEM), SRTM
Spatial Resolution: 30m
Legend
BAS Main Towns
BAS Main Rivers
BAS Main Roads
BAS Simplified Sub-Catchments
BAS Sub-Basin
Country Boundaries
DEM / Digital Elevation Model (masl)
< 500
500 - 1,000
1,000 - 1,500
1,500 - 2,000
2,000 - 2,500
> 2,500
Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84
Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study
aurecon
BRL ingénierie
Map Title: BAS Relief & Drainage
Date: March 2016
Rev: Draft Map
Prepared by: GTS Services (gtshsig@gmail.com)